LORAL
DATA SYSTEMS

CONIC

ADVANCED DECOM SYSTEM

ADS 100

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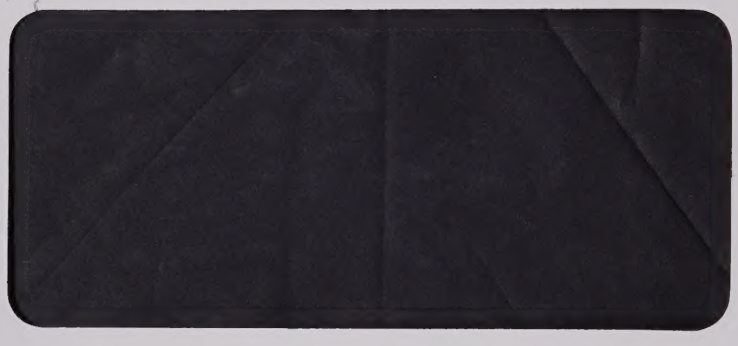

ADVANCED DECOM SYSTEM

ADS 100

CDS

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1.0 INTRODUCTION

This document describes the Advanced Decom System (ADS 100), presently in the final development stage at Conic Data Systems. The ADS 100 is based on the proven d/pad series of decommutation hardware, extending all of the d/pad capabilities and incorporating numerous additional data processing features. The application of advanced human engineering techniques has made the programming and operation of the d/pad the most simplified in the industry. The ADS 100 extends this performance and includes graphic CRT capability. Modular construction and bus organization allow effective hardware configuration to efficiently meet the needs of each application.

The ADS series of hardware is complete in terms of the functions normally associated with decommutation equipment and performs many tasks not usually included in telemetry equipment of this type. A significant feature of the system is the quick-look CRT display of data for analysis during check-out or decision making under test conditions. The ADS processes and displays a wide range of data formats. In addition to the standard IRIG PCM, PAM and FM formats, many unique formats can be accomodated. Interfaces are available for peripheral equipment such as strip-chart recorders, tape recorders, line printers and computers. Extensive diagnostic and self-test capability is included.

ADVANCED DECOM SYSTEM

SYSTEM DESCRIPTION

- MAIN/EXPANSION
- MASTER/SLAVE
- BASIC SYSTEM
  - MODULAR CONSTRUCTION
  - FULL ASCII KEYBOARD
  - GRAPHICS CRT
  - DUAL TAPE DECKS
  - 47 TO 400 HZ POWER
  - RACK MOUNT OPTION
- EXPANSION CHASSIS

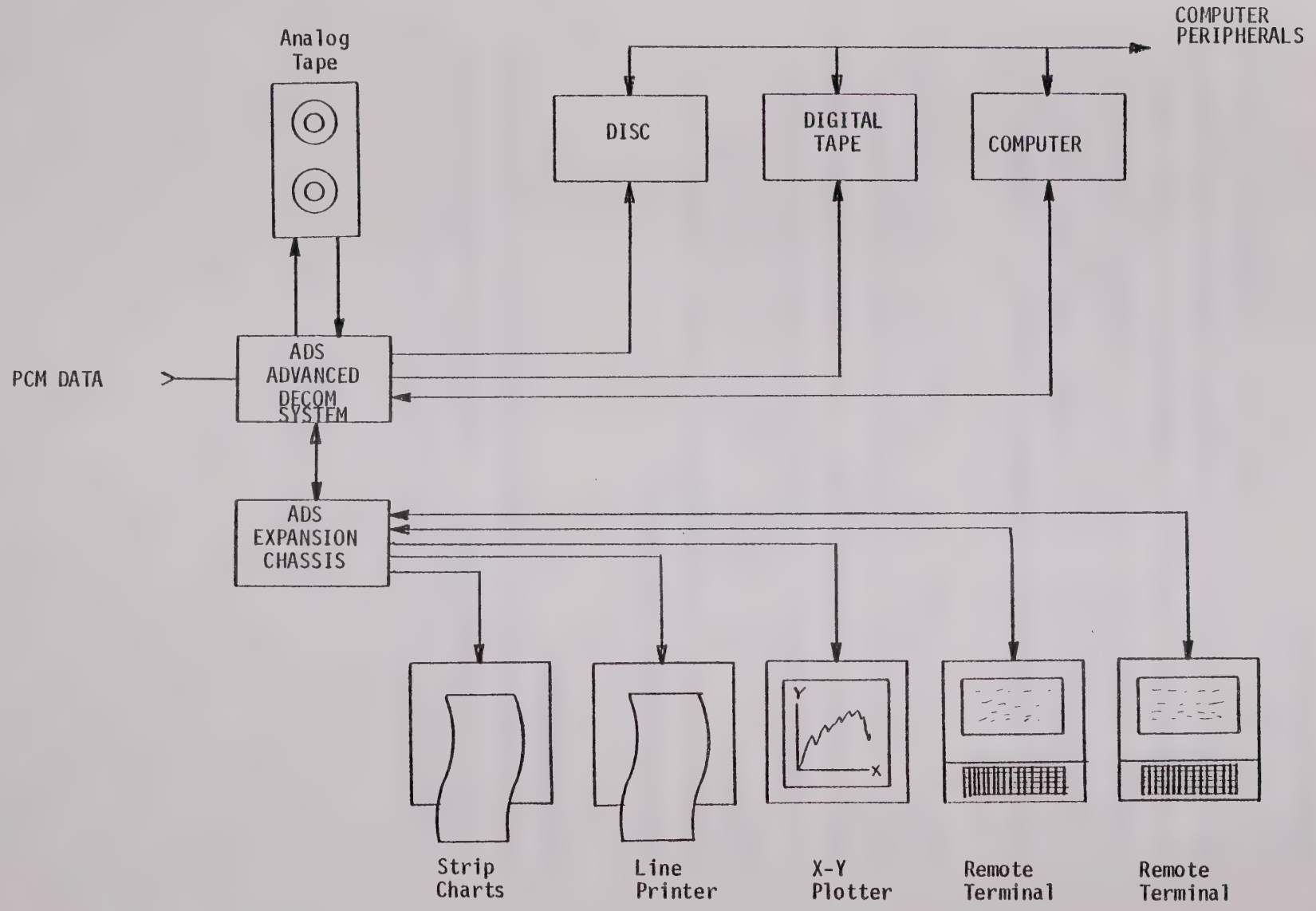
2.0 SYSTEM DESCRIPTION

The ADS 100 is a complete real time processing system which can accept the output of a telemetry receiver and deliver to the operator statistical information of a flight test program. Additionally, the unit will directly drive associated peripherals for mass storage, hard copy results and selected parameters for computer interface. (Figure 2.1).

The unit is expandable in two dimensions. Increased capability to handle a single PCM data stream and/or multiple data streams. (Figure 2.2 and 2.3). The increased capability is accomplished by the addition of an expansion chassis (Figure 2.9). The expansion chassis can assume one of two relationships to the basic system (Figure 2.5 and 2.6), main/expansion, master/slave.

2.1 Main/Expansion

This configuration is illustrated in Figure 2.2b where the expansion chassis serves to functionally extend the basic system capability to accept additional processing/IO modules.



ADS

GROUND STATION - REAL TIME TELEMETRY PROCESSING

FIGURE 2.1

2.2 Master/Slave

This configuration is illustrated in Figure 2.2c where the master station serves as the control and display section of a four stream network. Each slave can handle one data stream providing complete decommutation, processing and peripheral control. In addition, the slave outputs can be coupled to the master station where they are merged into the MUXbus and form a unified composite data stream. This data stream can then be processed and controlled by the master station with the attendant efficiencies of shared resources. This configuration also permits analysis of the relationship between the various streams and simplifies the correlation tasks of the processing computer.

Slave expansion is limited to eight (8) stations.

2.3 Basic System

The system design emphasizes rugged reliable operation and ease of maintenance. This emphasis is illustrated by the inclusion of built-in test capability (SIGNATURE ANALYSES, Temperature Monitor), worst case design criteria, modular construction and mechanical consideration. All connectors are pin-to-pin with locking mechanisms. A hold down strap secures all PCB modules

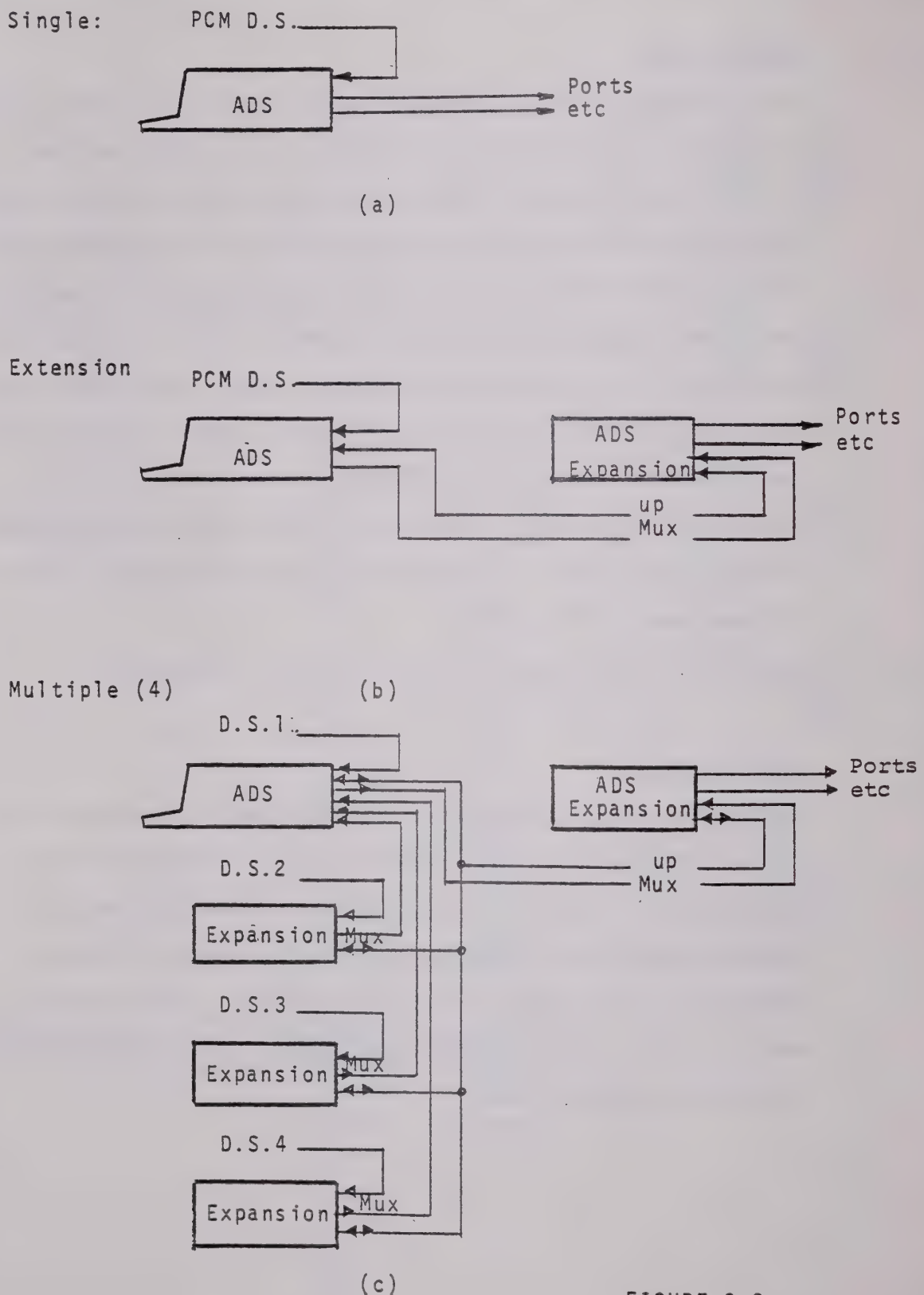
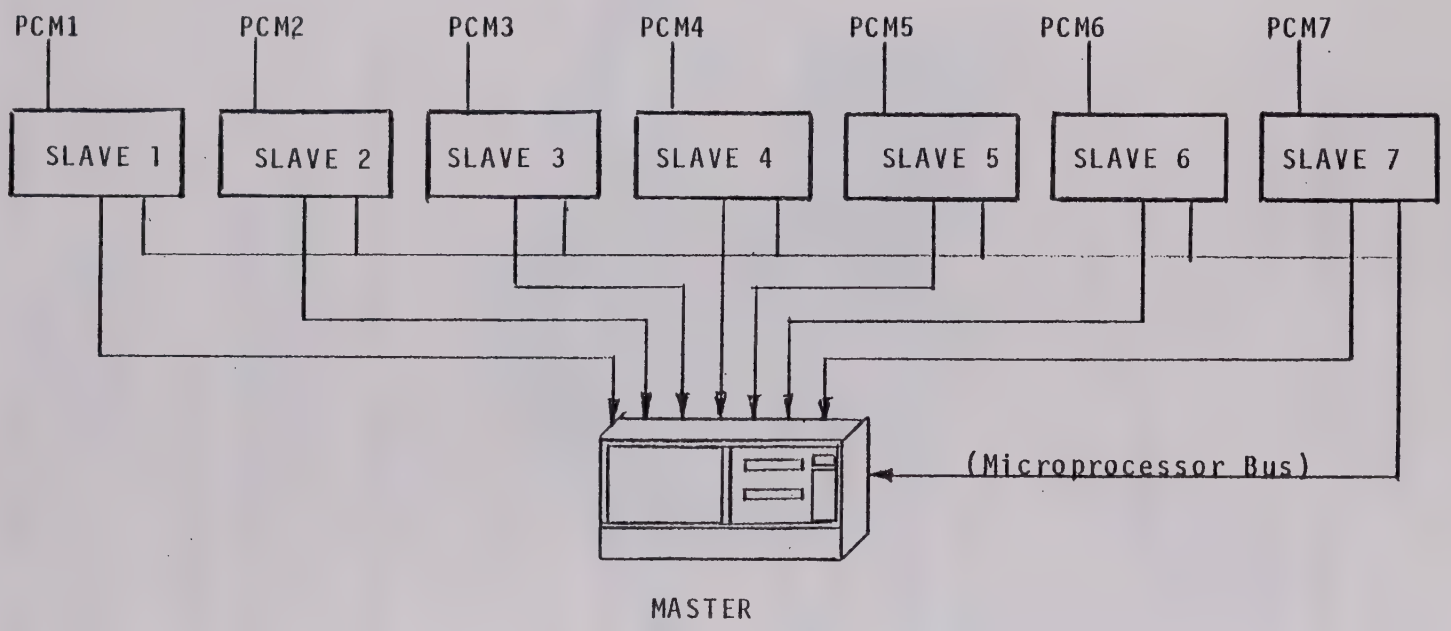

Single:
PCM D.S.
ADS
Ports
etc
(a)
Extension
PCM D.S
ADS
ADS
Expansion
Ports
etc
up
Mux
(b)
Multiple (4)
D.S.1
ADS
ADS
Expansion
Ports
etc
up
Mux
D.S.2
Expansion
Mux
D.S.3
Expansion
Mux
D.S.4
Expansion
Mux
(c)

FIGURE 2.2



MULTIPLE SLAVE ORGANIZATION

FIGURE 2.3

The basic unit (Figure 2.4 and 2.5) is of modular construction and consists of the following modules.

a) Chassis

b) Keyboard

c) Tape Recorders

d) Power Supply

e) CRT

f) Card Cage

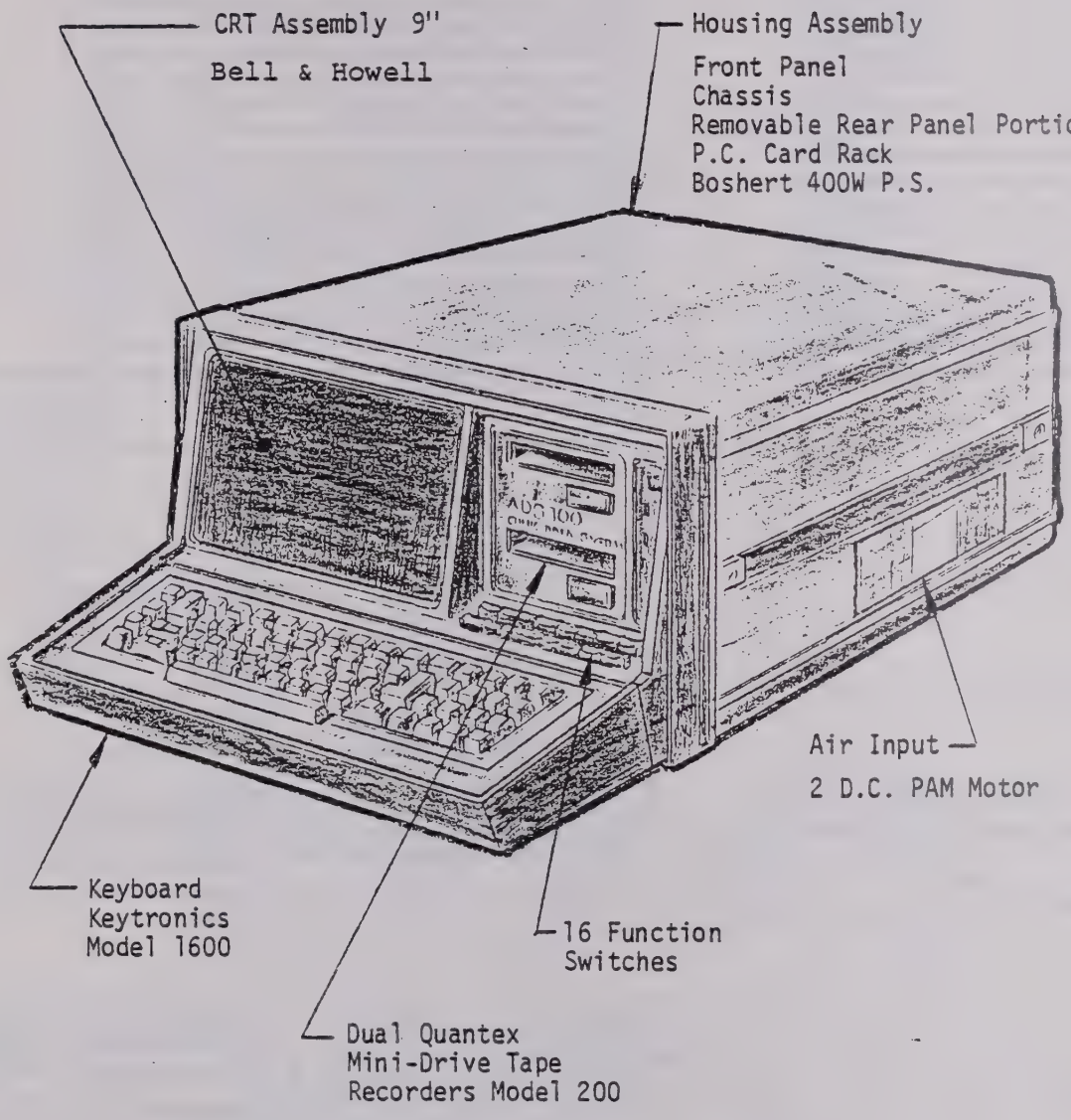
g) Front Panel

The Card Cage is further modularized into functional units as illustrated in Figure 2.6.

The overhead section contains the systems resources necessary to coordinate all module activity and control the system peripherals. This section consists of the front panel interface, CRT interface, microprocessor and memory expansion.

The decommutator section contains the elements necessary to synchronize the incoming data stream and deliver formatted data to the processors. The processors in turn analyze, modify and capture selected data.

The processor data is then routed to the peripheral controllers which deliver that data to the peripheral units.



BASIC SYSTEM

FIGURE 2.4

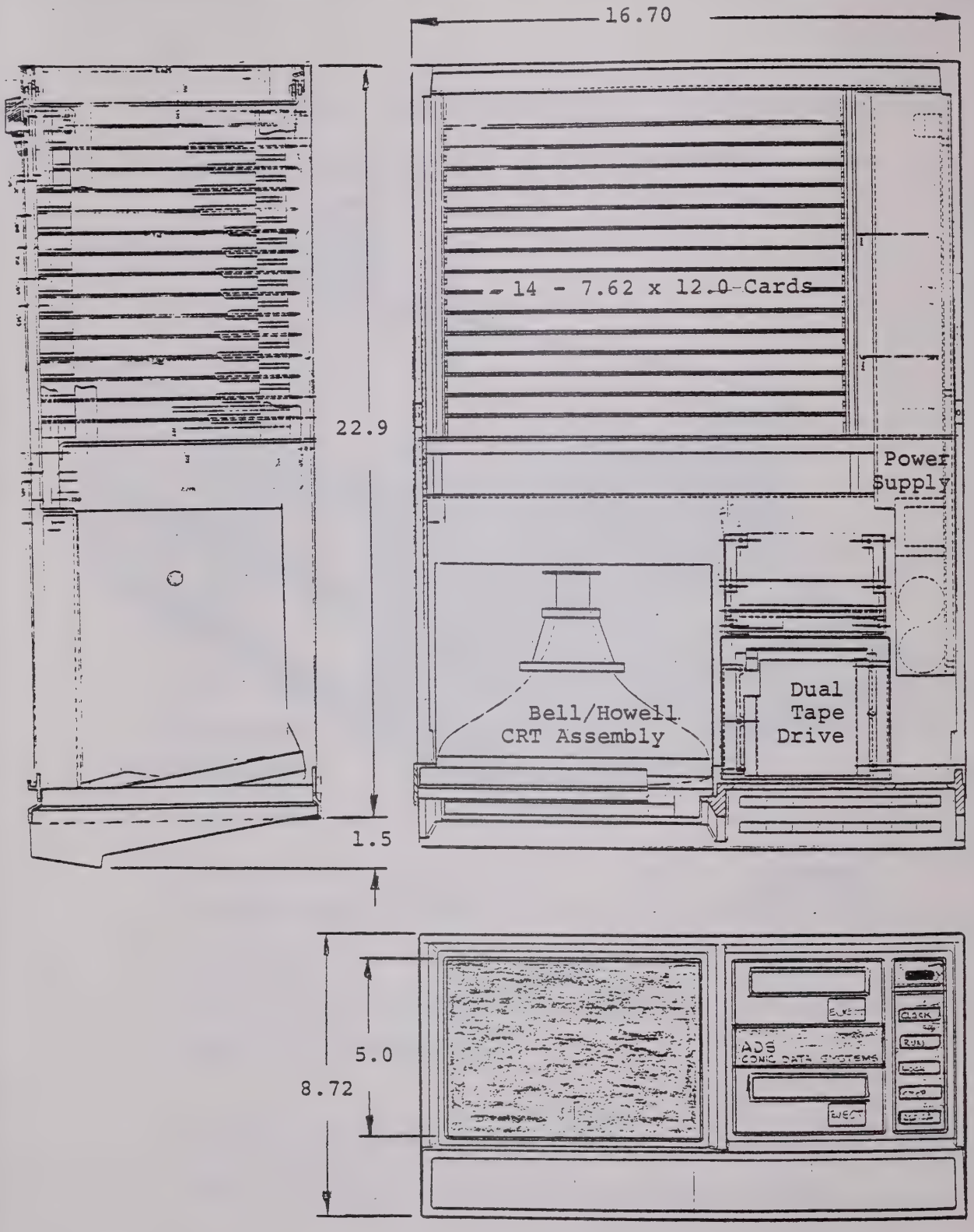


FIGURE 2.5

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ADVANCED DECOM SYSTEM

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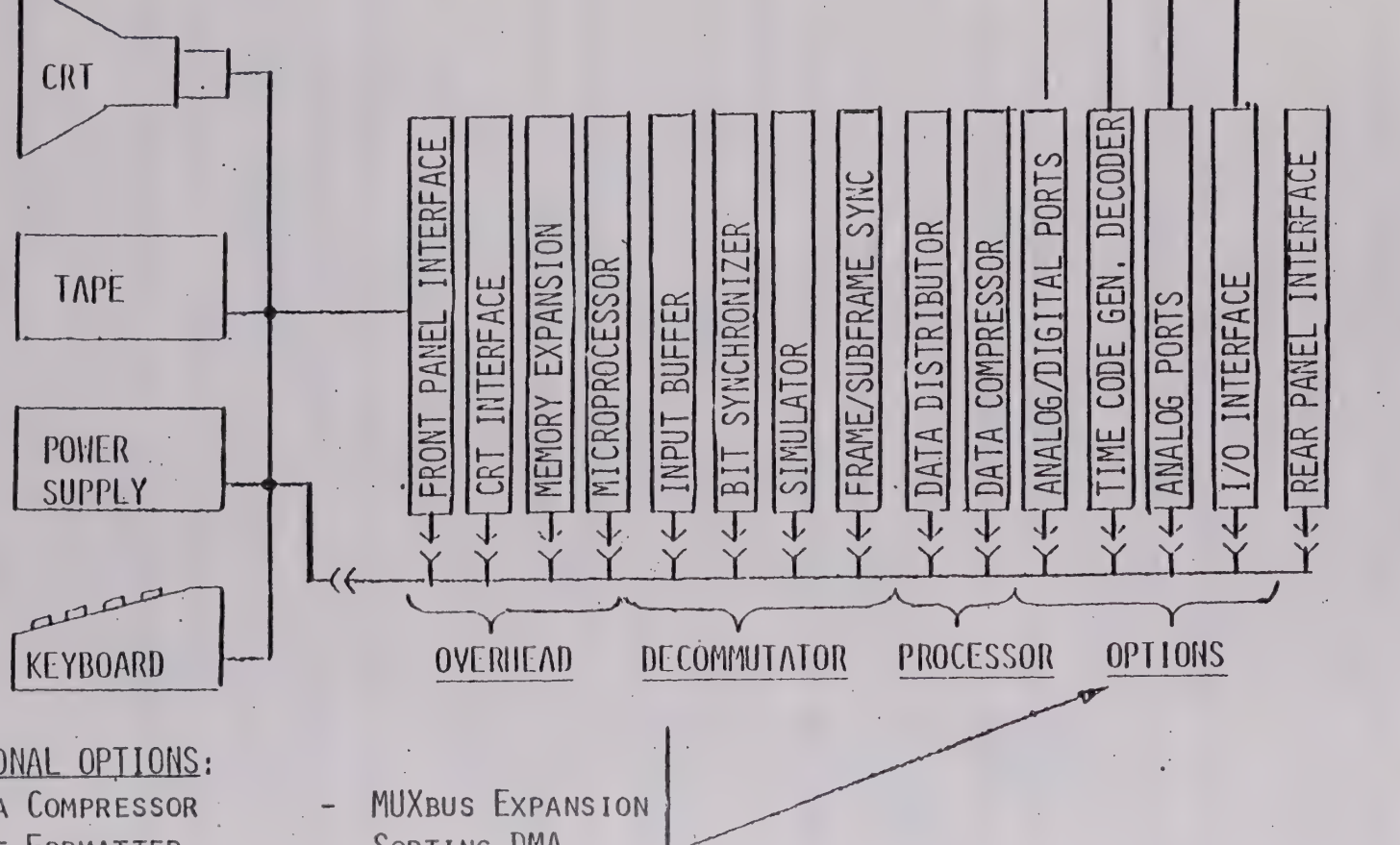

ADDITIONAL OPTIONS:

- Data Compressor
- Tape Formatter
- Disc Formatter
- Pan Converter
- Remote Terminal Interf.
- Data/Tag-Event Monitor Port
- 16-Channel Quantizer
- MUXbus Expansion
- Sorting DMA

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After set-up the data would be stored on the integral tape recorder for future reference.

The PCM data flow then proceeds as follows (See Figure 2.7 Block Diagram). The raw, noise contaminated PCM data stream is applied to one of the three (3) data sources on the unit back panel. It is then selected and routed to the input buffer where it is conditioned by automatic gain and offset control circuitry. Further processing performs bit synchronization, bit decision and code conversion. The reconstructed data along with a synchronous clock is then routed to the frame synchronizer. The frame sync examines each incoming data bit in a parallel digital correlator to determine the most likely location of the sync pattern. This information is then used along with the programmed sync strategy to generate the frame sync pulse. Sub-frame synchronization is executed in a like manner.

The data along with the sync pulses are then applied to the data distributor which provides serial-to-parallel conversion. In addition, the distributor performs all the required functions to interface with the MUXbus. These include bit alignment, data tagging, alarm limit checking and code conversion.

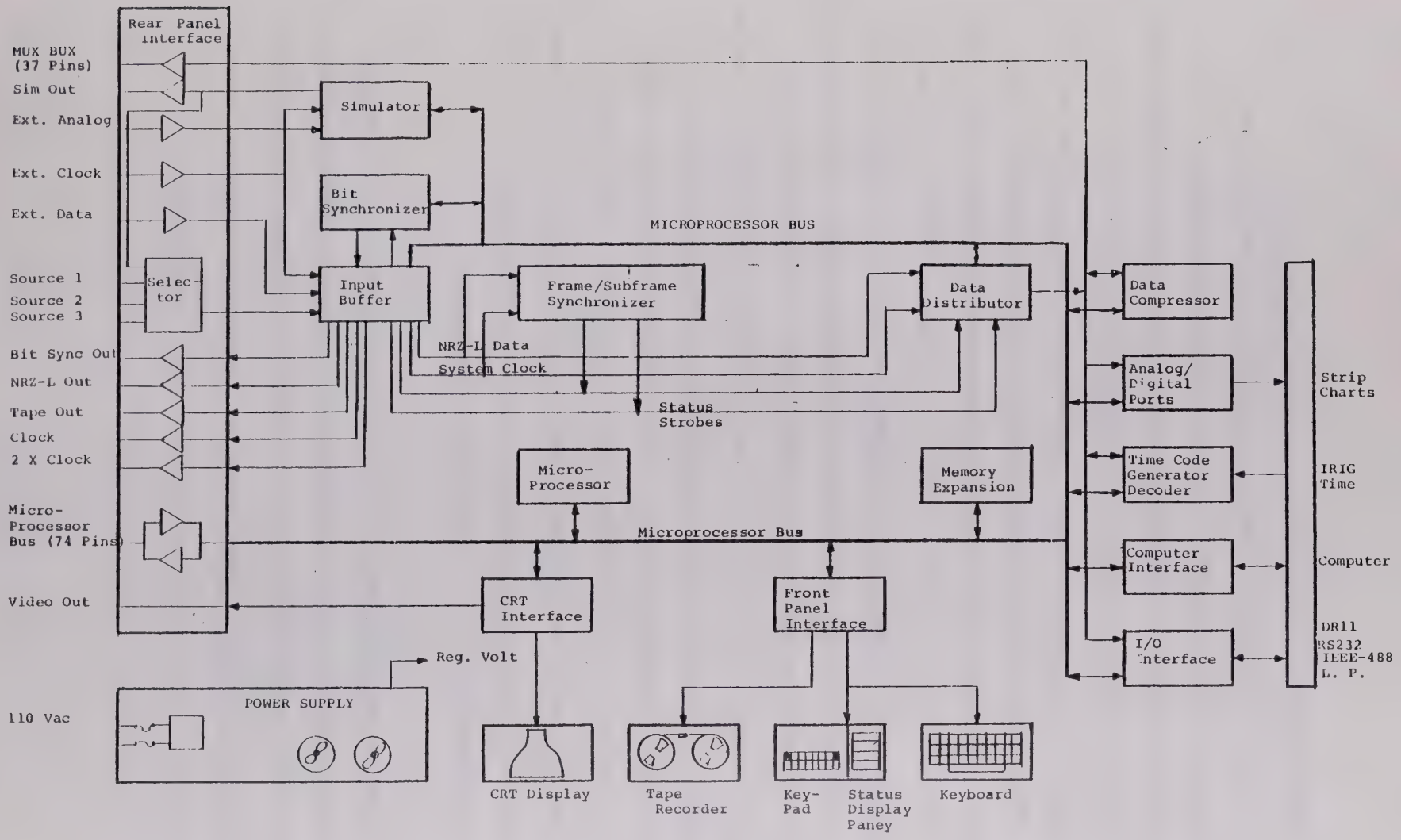


FIGURE 2.7

ADS 100 BLOCK DIAGRAM

2.3 BASIC SYSTEM (Continued)

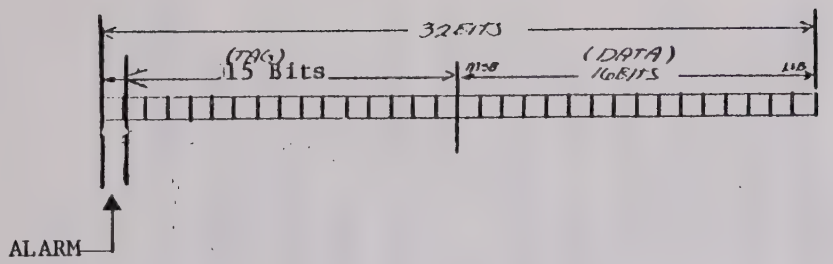
A typical operation scenario would proceed as follows: The operator would call up menu type display pages, using single keystroke commands and enter the telemetry data format specifications. The specifications would include bit rate, data code, bits/word, etc. In addition the operator would assign measurement names, alarm conditions, display format etc., to each of the operative parameters (PRIME DATA). If processing of the prime data was desired the operator would select the appropriate algorithm and similarly define each of these operative parameters (PROCESSED DATA). The operator would then define any parameters which were not directly measurable from the data stream (DERIVED PARAMETERS). These would typically be derived as an algebraic combination of prime and processed data. For example "Mass Air Flow" may not be a directly measured quantity in the flight test program but could be deduced from a calculation involving temperature, altitude, pressure, etc. Once defined it could be considered as if it were directly measured.

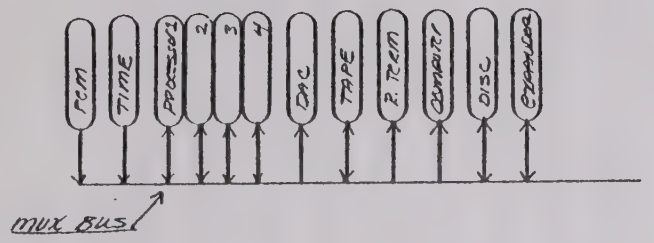
After parameter block definitions are complete the operator would be free of all references to the PCM telemetry format and could communicate with the machine in terms of parameter names and engineering units.

2.3 BASIC SYSTEM (Continued)

The MUXbus as illustrated in Figure 2.8 is a 32-bit, high speed (4 Mega Word) data bus. The 32 bits are divided in 3 groups; 16 bits for data, 15 bits for tag, and 1 bit alarm indication. All defined parameters are merged into the MUXbus using a circular priority scheme which insures that each data source is serviced within 2.25 microseconds. This capability supports 8 data streams at 5 Megabits/Stream, 12 Bits/Word).

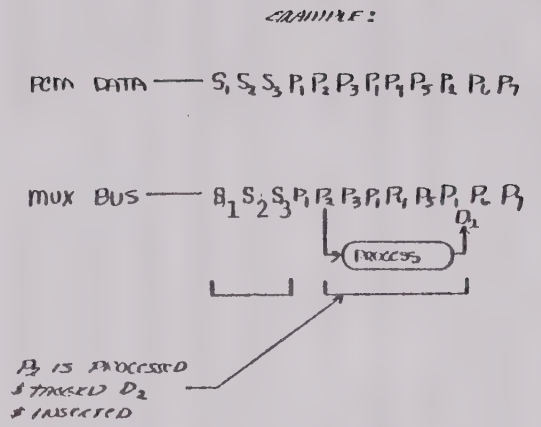
After the data has been deposited on the bus along with its associated tag it can be selectively captured and distributed to any/all peripheral support circuitry. As an example: "OIL PRESSURE" could be defined as a prime parameter which is to be routed to an analog port, computer interface and serve as the source for a processed parameter "OIL PRESS PEAK". In this example, each of the associated modules would be programmed to caputure "OIL PRESSURE", so that in one bus cycle the data would be distributed to all destinations. The analog port module would then convert the captured data into an analog voltage, the computer interface would format the data and deliver it to the computer, and the compressor modules would perform the appropriate algorithm. To complete the example assume that the data value met the compressor output criteria. Then the compressor would deposit the appropriate data onto the bus with a new tag "OIL PRESS PEAK".





Arrow indicates data flow

EXAMPLE:



NOTES:

1. Each bus transaction contains 16 bits of data and an accompanying tag. The tag identifies the data. If any process modifies the data in any way, e.g., mask bits, shift left, peak detect or delay in time, then the tag is modified to reflect the process.

2. Data is MSB Aligned

3. P = Parameter
   S = Sync

MUX BUS FORMAT

FIGURE 2.8

2.3 BASIC SYSTEM (Continued)

Next, assume that the prime parameter "OIL PRESSURE" met the previously described alarm condition. Then the data would be automatically captured and delivered to the alarm processor. There it would enter a que based on the specified priority. If it were the highest priority of pending alarms it would be displayed at the top of the display page along with an associated alarm message. Further, it could trigger an automatic response such as, audio beep, output to line printer, call subroutine or special function button sequence.

The alarm que is available for examination and associated commands are provided, such as, Alarm Priority Limits, Alarms OFF, etc.

2.4 EXPANSION CHASSIS

The expansion chassis gives the user the capability to decommutate more PCM streams or add additional optional modules to the systems.

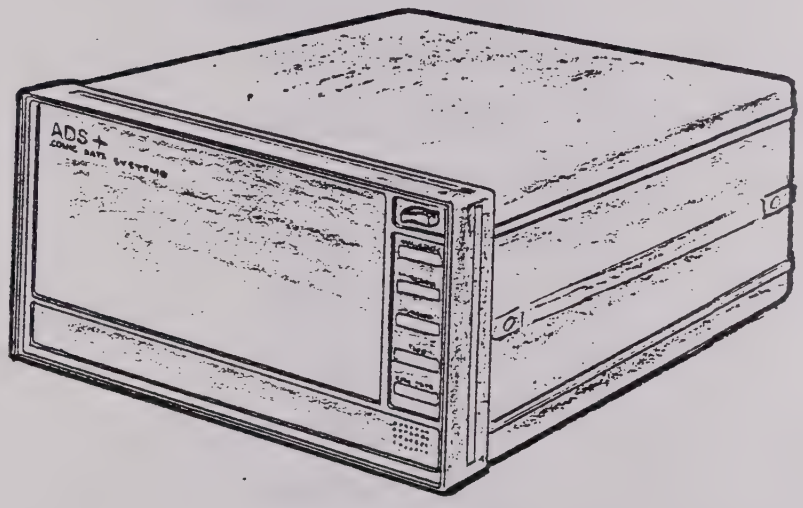
To deocmmutate another PCM stream, the expansion chassis will be configured with an input buffer, bit synchronizer, frame/subframe synchronizer and data distributor (these four modules, when used together, make up a basic PCM front-end). A front panel and rear panel interface module will also be needed to drive the status display panel

2.4 EXPANSION CHASSIS (Continued)

and buffer the MUXbus back to the MASTER ADS. The remaining slots may be used for optional modules.

When used strictly as an expansion chassis, the unit will be configured with the front and rear panel interface modules, as well as the MUXbus Expansion Interface module. This will leave eleven slots available for options.

If additional slots are needed for optional modules, the expansion chassis may be cascaded.



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EXPANSION CHASSIS

FIGURE 2.9

ADVANCED DECOM SYSTEM

SYSTEM FEATURES

- MAN/MACHINE INTERFACE
  - MENU PAGE DISPLAYS
  - ENGLISH LANGUAGE SYSTEM COMMANDS
  - PROGRAMMABLE SOFT KEYS
  - FULL ASCII KEYBOARD
  - STATUS PANEL
  - TAPE SYSTEM
- ALARM SYSTEM
  - ALARM DISPLAY
  - ALARM PRIORITY
  - AUDIO ALARM
- DATA ANALYSIS
  - REAL TIME PROCESSING
    - LIMIT CHECKING
    - DATA COMPRESSION
    - ENGINEERING UNITS CONVERSION

- SOFTWARE PROCESSING
  - DERIVED PARAMETERS
  - ENGINEERING UNITS CONVERSION
- DATA DISPLAYS
  - EU DATA DISPLAY
  - BAR CHARTS
  - CROSS PLOTS
  - OSCILLOGRAPH

- SELF TEST
  - INTERNAL SIMULATOR
  - SIGNATURE ANALYSIS
  - DIAGNOSTIC CRT DISPLAY
  - TEMPERATURE MONITOR
- TIME CORRELATION
  - INTERNAL SYSTEM TIME
  - EMBEDDED TIME
  - IRIG DECODED TIME
- USER PROGRAMMABLE
  - EDITOR
  - MEMORY CRT DISPLAY
- PARAMETER BLOCK

3.0 SYSTEM FEATURES

The ADS 100 is designed to serve as a complete small ground station and/or a real time processing front end for a major ground station installation. The unit is equipped with an effective man-machine interface emphasizing simplified commands, soft key functions and menu page displays. Also included is a complete operating system with emphasis on alarm and data analysis. The operational scenario includes real time data analysis during a flight test program with specific interest in safety of flight and quality of maneuver.

3.1 Man-Machine Interface

The man-machine interface is accomplished with a combination of system commands, menu type page displays and audio visual feedback. The underlying design philosophy invisions three levels of system users. The flight test engineer with primary interest in the data analysis/display functions, the telemetry engineer with emphasis on equipment setup and maintenance, and the system design engineer with a desire to tailor the unit for new and unusual requirements.

The first level user is accommodated by inclusion of soft keys and special function keys, which permit operation by a single keystroke and/or specifically labeled function keys. The second user is aided by command line programming and menu type page displays. This permits a review of the acceptable

program alternatives and requires only an understanding of telemetry vocabulary to operate the unit. The third is accommodated by structural sophistication and a user software module programmable from the keyboard in machine language.

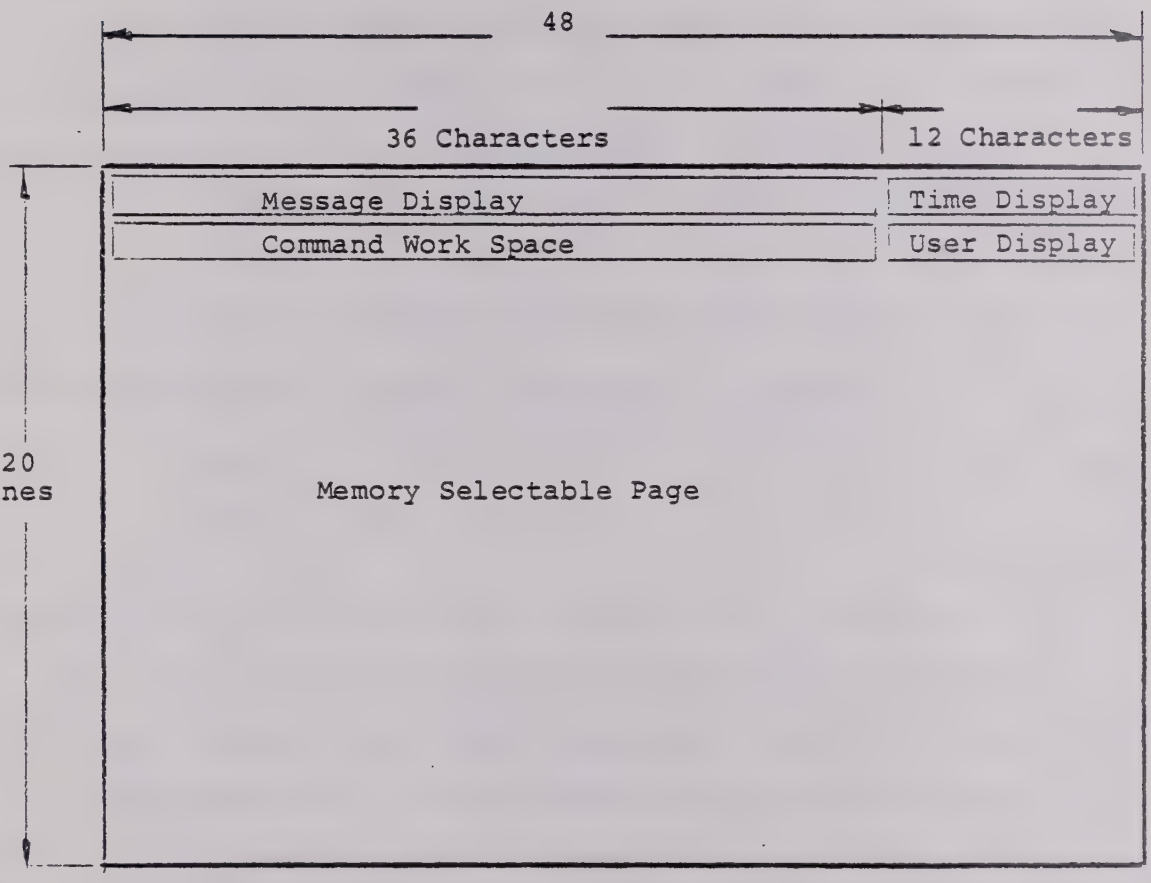
3.1.1 Page Formats

The CRT page is comprised of 20 lines of 48 characters each. (Figure 3.1). The top line is reserved for message and time display. The message display area utilizes the first 36 character position and the remaining 12 positions are reserved for time display, e.g., (time of day from internal clock, embedded time display, IRIG Time Display).

The first 36 positions of the second line are reserved for command line programming with the last 12 positions addressable by the user for miscellaneous data such as flight number, etc. The remaining 18 lines are used to display the various programming pages and data displays.

3.1.2 Commands

System commands are entered on the second line of the page as previously described. A system command consists of a string of english language words, e.g., (DISPLAY BIT SYNC) which when displayed and executed causes the indicated response.



CRT PAGE FORMAT

FIGURE 3.1

3.1.3 Soft Keys

The unit is equipped with two rows of 8 keys each of which consists of 14 special function keys and two support functions. One of the support functions is system reset which when depressed causes the microprocessor to execute the reset program. The remaining 15 keys implement the soft key capability and are labeled F1-F14 and PRGM.

The function of the soft keys is to permit the operator to define a sequence of keystrokes and have the sequence repeated upon the depression of a single key.

3.1.4 Keyboard

The keyboard is the operator's primary access to the system. It is based on a 72-key typewriter with alphanumeric and special character functions. Special features include an auto repeat, two key rollover, and an illuminated (LED) shift lock key. Switch reliability is rated at 100 million closures between failure to ensure sustained performance. Attachment to the system is through a single 25 pin connector to the front face with sufficient cable length to allow relocation for ease of use. When close proximity is desired a pocket is provided in the base of the keyboard to store unused cable length.

3.1.5 STATUS PANEL

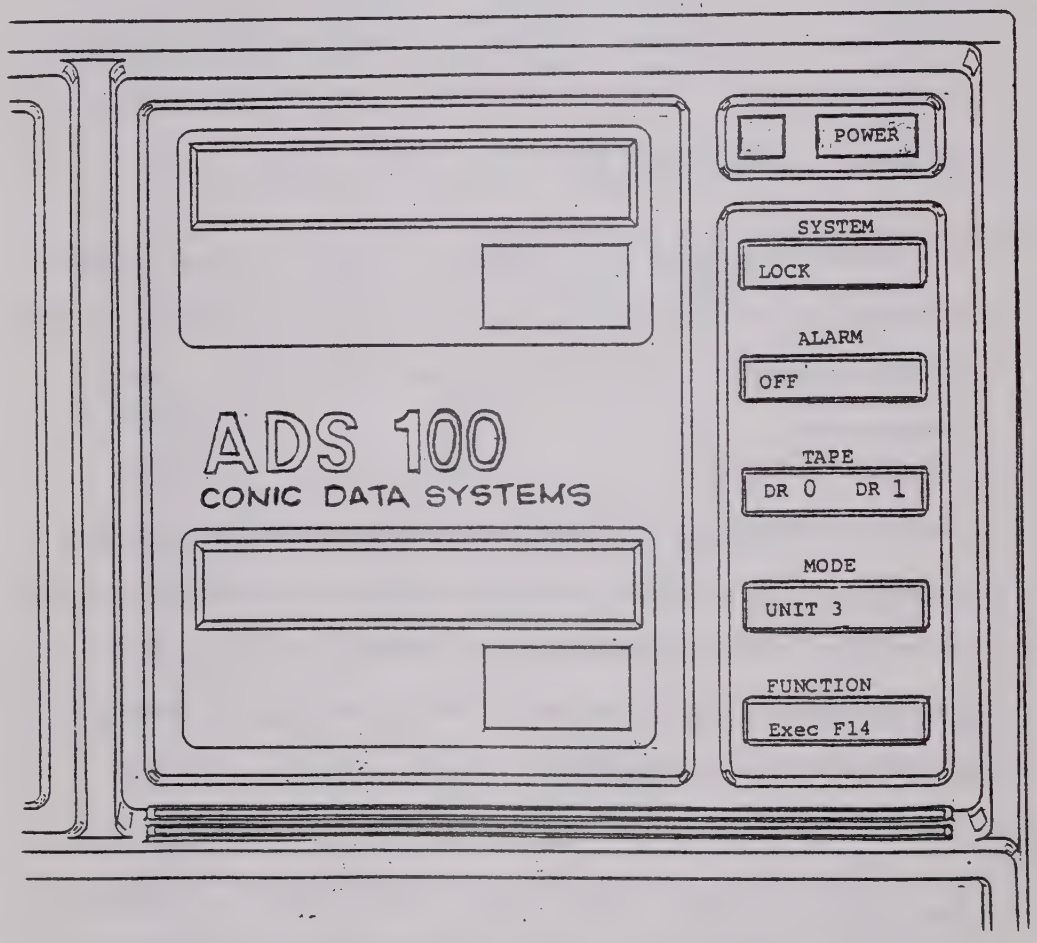
The Status Panel is a group of 5 displays comprised of 8 characters each with 14 segments per character located directly below the main power switch. During operation these displays give a "quick look" status of the system. The first display indicates the system status. This status is LOCK indicating data is being processed, BIT ERROR indicating loss of lock and the system is searching for a bit lock, etc.

The second display indicates the Alarm status as programmed by the operator. Specific alarms which do not cause automatic response will be indicated on each occurrence.

The third display is the Tape Status and informs the operator which drive and track number is in use. Once specified at the keyboard the drive and track are remembered by the processor and this display serves as an echo to the operator.

The fourth is the mode status and is used to identify the system within a network when multiple processing is required.

The fifth display is the special function key display and indicates when the operator is programming, executing, etc., the special function keys.



STATUS DISPLAY PANEL

FIGURE 3.2

3.1.6 Tape System

A dual tape record/playback system is provided which allows storage of program information, data, data analysis packages or flight logs. Two dual track Quantex Mini-drives (Model 2ØØ) are used for this function. Tapes are preformatted into tagged block before any information is stored. This allows high speed searches to be performed efficiently. Data is stored at 16ØØ bpi in 256 files of 512 bytes each on each track giving a total formatted capacity of over 500,000 bytes of data. Files are accessed by name and are listed in a displayable directory which gives name, track #, drive #, file # and size for each file. This directory is composed upon power-up and maintained thereafter.

```
<ØØØ>                                        Ø71 12:12:49
>DISPLAY TAPE DIRECTORY

   FILE NAME          TAPE   DRIVE  TRACK  FILE#  SIZE
 SA2731               SETUP    Ø      Ø     ØØ1    Ø23
 SA2257               SETUP    Ø      Ø     Ø24    Ø17
 ≪BLANK≫              -----    Ø      Ø     Ø41    216
 SA2731 LL.62         DATA     Ø      1     ØØ1    Ø73
 ≪BLANK≫              -----    Ø      1     Ø74    143
 SA2257  HL.7         DATA     Ø      1     217    ØØ9
 ≪BLANK≫              -----    Ø      1     226    Ø31
 FFT ANALYSIS         PROG     1      Ø     ØØ1    Ø43
 ≪BLANK≫              -----    1      Ø     Ø44    213
 FLT 82  Ø1-Ø7-8Ø     LOG      1      1     ØØ1    Ø22
 ≪BLANK≫              -----    1      1     Ø23    Ø42
 FLT 83  Ø1-12-8Ø     LOG      1      1     Ø65    Ø91
 ≪BLANK≫              -----    1      1     156    Ø1Ø
 FLT 84  Ø2-17-8Ø     LOG      1      1     166    ØØ7
 ≪BLANK≫              -----    1      1     173    ØØ3
       USE SCROLL↓ TO SEE MORE
```

FIGURE 3.3 - TAPE DIRECTORY DISPLAY

3.1.7 Audio Feedback

The unit is equipped with an audio tone generator which provides audio feedback (.5 sec 400 Hz) at the conclusion of a successful program entry or (.5 sec 800 Hz) if an illegal operation is attempted. It also provides a pulsed tone (25 sec. 1000 Hz, 4 pulses) in the event of an alarm.

3.2 ALARM SYSTEM

The alarm system is provided in the ADS to prioritize and route various types of alarms such as data errors, command errors, command warnings, system errors and system warnings. The alarm system will select the highest priority alarm for display on the top line of the CRT and allow the operator to cancel alarms selectively or by groups. An alarm page is also provided so the operator may see several of the current alarms at once (See Figure 3.4). Alarms involving data may result in a display of data values and/or messages if so programmed in the appropriate parameter block. Other types of alarms may only display a message on this page. The alarm display page can be scrolled up or down in order to see the entire list of alarms. This scrolling feature combined with the appropriate key sequence will allow the operator to conventiently cancel individual alarms while on

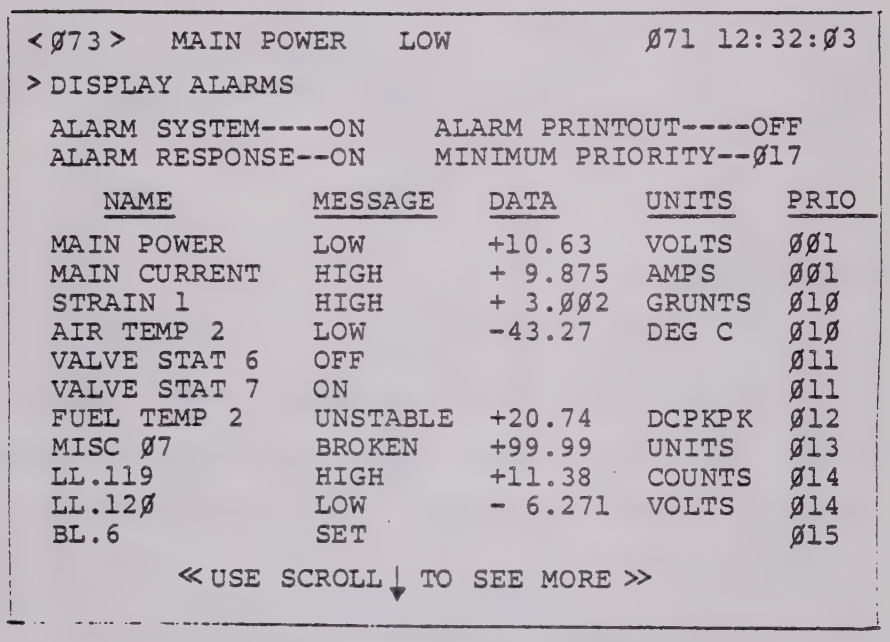

<Ø73> MAIN POWER LOW Ø71 12:32:Ø3
>DISPLAY ALARMS
ALARM SYSTEM----ON ALARM PRINTOUT----OFF
ALARM RESPONSE--ON MINIMUM PRIORITY--Ø17
NAME MESSAGE DATA UNITS PRIO
MAIN POWER LOW +10.63 VOLTS ØØ1
MAIN CURRENT HIGH + 9.875 AMPS ØØ1
STRAIN 1 HIGH + 3.ØØ2 GRUNTS Ø1Ø
AIR TEMP 2 LOW -43.27 DEG C Ø1Ø
VALVE STAT 6 OFF Ø11
VALVE STAT 7 ON Ø11
FUEL TEMP 2 UNSTABLE +20.74 DCPKPK Ø12
MISC Ø7 BROKEN +99.99 UNITS Ø13
LL.119 HIGH +11.38 COUNTS Ø14
LL.12Ø LOW - 6.271 VOLTS Ø14
BL.6 SET Ø15
≪USE SCROLL↓ TO SEE MORE ≫

FIGURE 3.4 - ALARM DISPLAY

this page. Alarms are listed in order of priority. System and command error and warning priorities are fixed by the system software. Data priorities are programmed by the operator in the appropriate parameter block.

3.3 Data Analysis/Display

The data analysis system consists of four main categories:

a) Real Time Processing
   - limit checking (ALARMS)
   - data compression
   - engineering unit conversion

b) Software Processing
   - derived parameters
   - engineering unit conversion

c) Data Displays
   - EU data display
   - Bar Charts
   - Cross Plots
   - Oscillograph

d) Data Analysis
   - Statistical summaries
   - histograms
   - cross correlation
   - regression analysis
   - spectral analysis

3.3.1 Real Timing Processing

Real time processing refers to hardware intensive capabilities which operate at the full data speeds without interruption. These capabilities include real time limit checking and data compression. Limit checking is accomplished by the features described previously under Alarm system. Real time engineering unit conversions are accomplished by the data compressor working in conjunction with an analog port.

Data compression is implemented in the data compressor module by a high speed bit-sliced microcomputer. Data can be handled normally in word lengths of up to 16-bits, with special algorithims available for longer words. Each module is capable of processing any 256 selected parameters.

A typical algorithm requires approximately 4 microseconds. The through-put time as well as the number of definable parameters can be increased by installing additional modules. For example, if two modules are installed processing capability expands to 512 parameters with a typical through-put time of 2 microseconds. (Note: Not more than 4 compressor modules can be installed in the same chassis).

Data compression algorithms are as follows (the brackets indicate operator options, i.e., operator can enter values in either format):

1. In Limits (ILI). Output parameter if its value is within the programmed limits.

   Algorithm . . . . . In Limits
   Upper Limit . . . [Counts] [Floating Point]
   Lower Limit . . . [Counts] [Floating Point]

2. Out of Limits (OLI). Output word if its value is outside the programmed limits.

   Algorithm . . . . . Out of Limits
   Upper Limit . . . [Counts] [Floating Point]
   Lower Limit . . . [Counts] [Floating Point]

3. Nth Word (NSE). Discard N-1 sequential samples of a particular parameter, then output the Nth sample. N is a programmable variable.

   Algorithm . . . . . Nth Word
   N Equals 00001-65535

4. Bit Change (BCH). Output word if selected bits have changed since last word output.

Algorithm . . . . . Bit Change

Mask . . . . . [HEX] [Binary]

Pattern . . . . [HEX] [Binary]

5. Bit Match (BMA). Output word if selected bits match a preset pattern.

Algorithm . . . . . Bit Match

Mask . . . . . [HEX] [Binary]

Pattern . . . . [HEX] [Binary]

6 Not Bit Match (NBM). Output word if selected bits do not match a preset pattern.

Algorithm . . . . . Not Bit Match

Mask . . . . . [HEX] [Binary]

Pattern . . . . [HEX] [Binary]

7. Delta (ZFN). The first sample of a parameter is outputted and a programmed delta corridor is established with the transmitted value as the midpoint. Each subsequent sample that falls within the delta corridor is rejected as being redundant until a sample falls outside the delta corridor. That sample is transmitted and the corridor is adjusted using the transmitted sample as the center value.

7. Delta (ZFN) (Continued)

Algorithm . . . . . Delta

Corridor . . . . [Counts] [Floating Point]

8. Delta Slope (DSL). Output the preceeding sample if the sign of the slope of the present sample has changed and the level has changed by more than a specific corridor.

Algorithm . . . . . Delta Slope

Corridor . . . . [Counts] [Floating Point]

9. Peak-to-Peak (PTP). Output the difference between the maximum and minimum values of a parameter over a period of N samples. N is a programmable variable.

Algorithm . . . . . Peak-to-Peak

N Equals . . . 00001-65535

10. Average Over N (AVN). Output the average value of a parameter over N samples, where N is a programmable power of 2.

Algorithm . . . . . Average

N Equals . . . . 1, 2, 4, 8, etc.

The engineering units conversion algorithm is as follows:

11. Conversion (EUC). Output the particular parameter after engineering unit conversion.

    a. Algorithm - - - - - Conversion

       Equation - - - - - Y = mx + b

    b. Algorithm - - - - - Conversion

       Y = ABCD at X = 0040, 00C0, 0140, etc. counts

0040	00C0	0140	01C0	0240	02C0	0340	03C0
0040	04C0	0540	05C0	0640	06C0	0740	07C0
0840	08C0	0940	90C0	0A40	0AC0	0B40	0BC0
0C40	0CC0	0D40	0DC0	0E40	0EC0	0F40	0FC0

Note: This algorithm is based on 12-bit resolution of the analog-to-digital and digital-to-analog converters

3.3.2 Software Processing

Software processing refers to operations performed on the data by the host microprocessor. It is distinguished from real time processing by speed and flexibility. Software processing has reduced speed but enhanced flexibility. The processing is performed by a 4 MHz 16-bit microprocessor (INTEL 8086) supported by a hardware math module (AMD 9511A). Functions accomplished by software processing includes derived parameter processing and most of the engineering units conversion.

3.3.3 Data Displays

Data display is accomplished on the CRT in two forms, alphanumerical (ASCII) and graphic. The alphanumeric display is developed from a 7 x 9 character embedded in a 9 x 15 field. The graphic capability provides complete pixel control (129,600 pixels) with up to 4 shades of gray for each pixel.

The data displays are shown in Figures 3.5 and 3.6 Figure 3.7 illustrates the engineering units display page. The data for display is specified by measurement name. (Note: Up to 16 characters are printed for the name. The displayed value, format and units are as defined by the parameter block page (See Section 3.7)

```
 <ØØ9> ALARM CONDITION (HIGH TEMP)          12:59:59
>DISPLAY DATA PAGE                           FLT 111

        PARAMETER          VALUE             UNITS

 1  OIL PRES Ø1        XXXXXXXXXXXXX     LB/SQ.
 2  OIL TEMP C         XXXXXXXXXXXXX     DEG/C
 3
 4
 5
 6
 7
 8
 9
10  FUEL FLOW C        XXXXXXXXXXXXX     FT/SEC
11  FUEL FLOW D        XXXXXXXXXXXXX     FT/SEC
12  BATT CURR 8        XXXXXXXXXXXXX     AMPS
```

FIGURE 3.5

ENGINEERING UNITS DISPLAY PAGE

The bar chart (Figure 3.6) is an extension of the EU display page where each of the displayed parameters are shown as the height of a veritcal bar. The bar on the left is associated with the top line of the EU page and each subsequent bar is related to its respective line. (Alarm indication is shown as a bright line cutting the bar at the specified limit).

Illustrations of the cross plot capability are shown in Figures 3.7 and 3.9 where selected parameters are plotted.

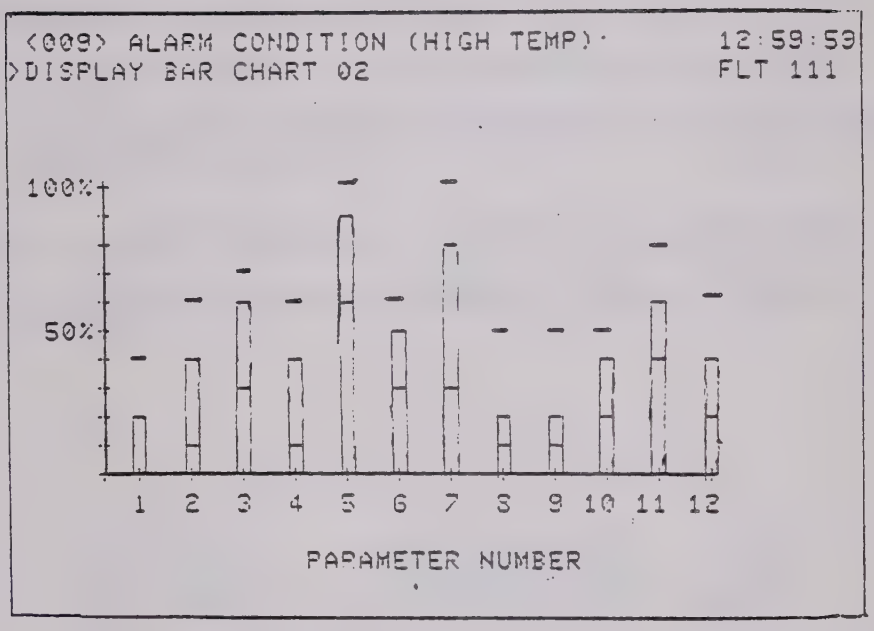


FIGURE 3.6

BAR CHART DISPLAY PAGE

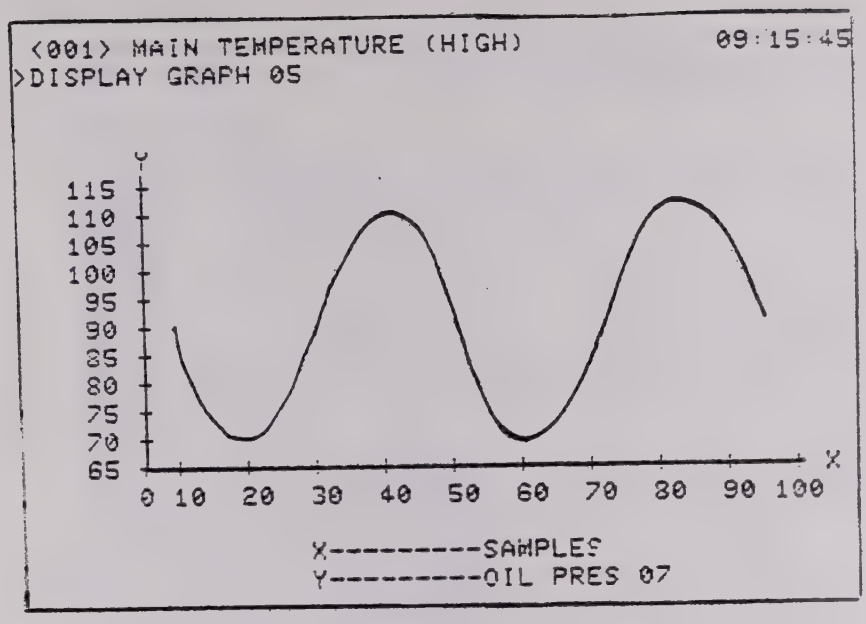


FIGURE 3.7

SINGLE PARAMETER PLOT

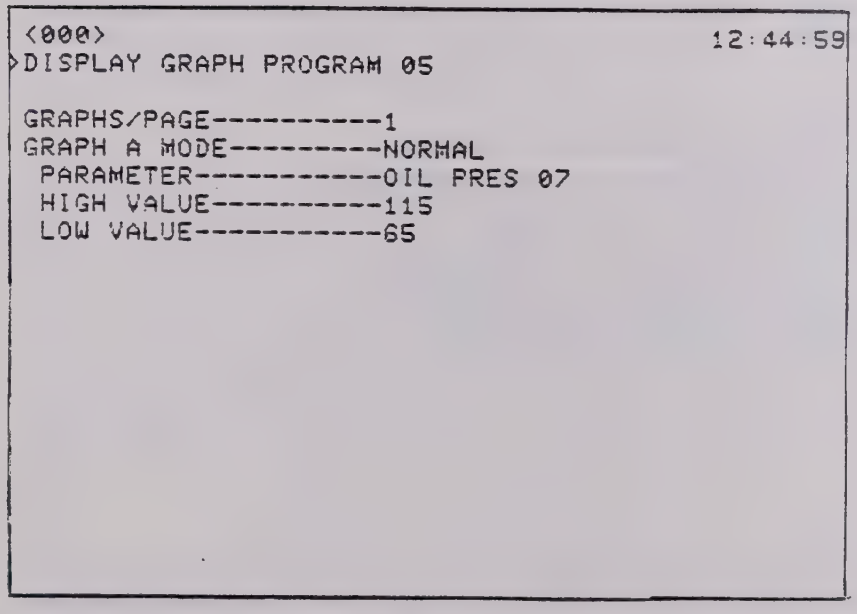


FIGURE 3.8

SINGLE PARAMETER PLOT MENU

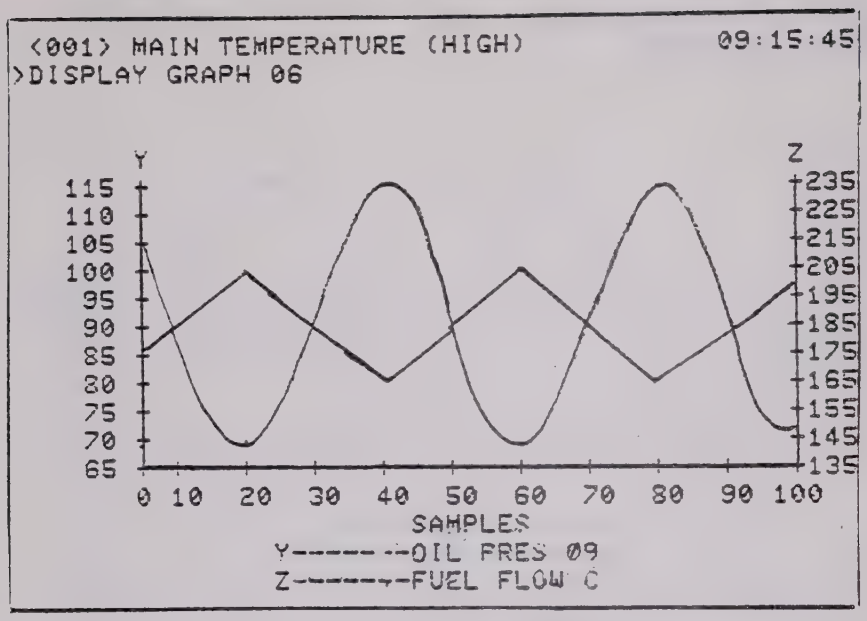


FIGURE 3.9
TWO PARAMETER PLOT

(Distinguished by Intensity)

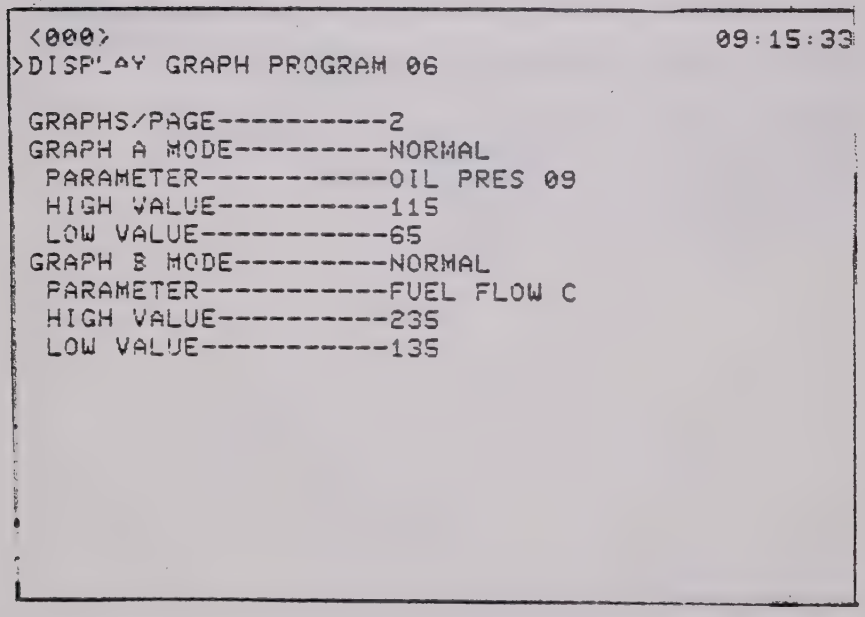


FIGURE 3.10

TWO PARAMETER PLOT MENU

3.3.4 Data Analysis

The data analysis capability listed is planned as a future development and includes:

- statistical summaries
- histograms
- cross correlation
- regression analysis
- spectral analysis

3.4 Self Test

The system is designed with built-in test and diagnosis capability. This is provided by an integral simulator, SIGNATURE ANALYSIS, Diagnostic page display (Figure 3.11) and temperature monitor.

The simulator provides the system stimulus and permits exercising all the system functions. It also contains the Signature Analysis encoder circuitry required to utilize this feature. (Note: The simulator is further described in paragraph 4.6).

Signature analysis provides the unit with the ability to test each of the circuit cards within the system and determines which if any are malfunctioning.

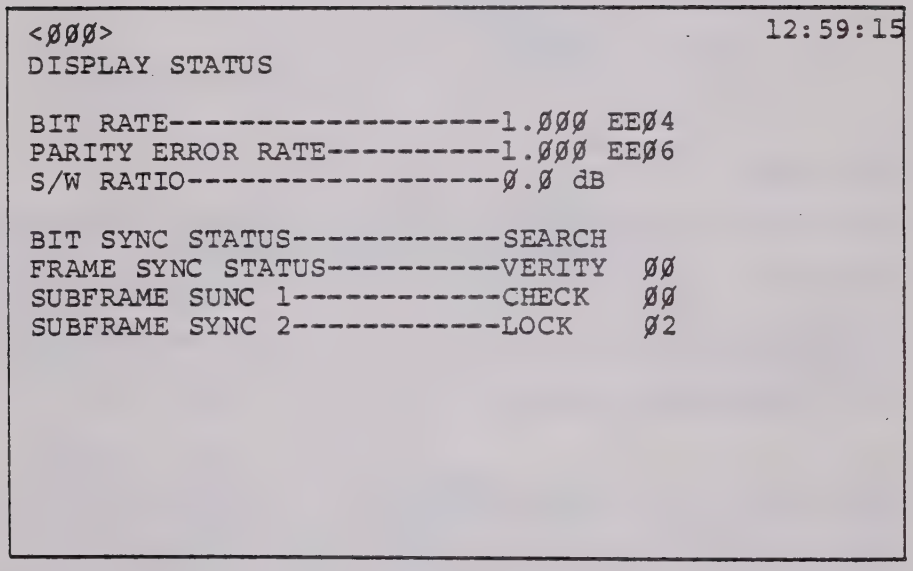


FIGURE 3.11

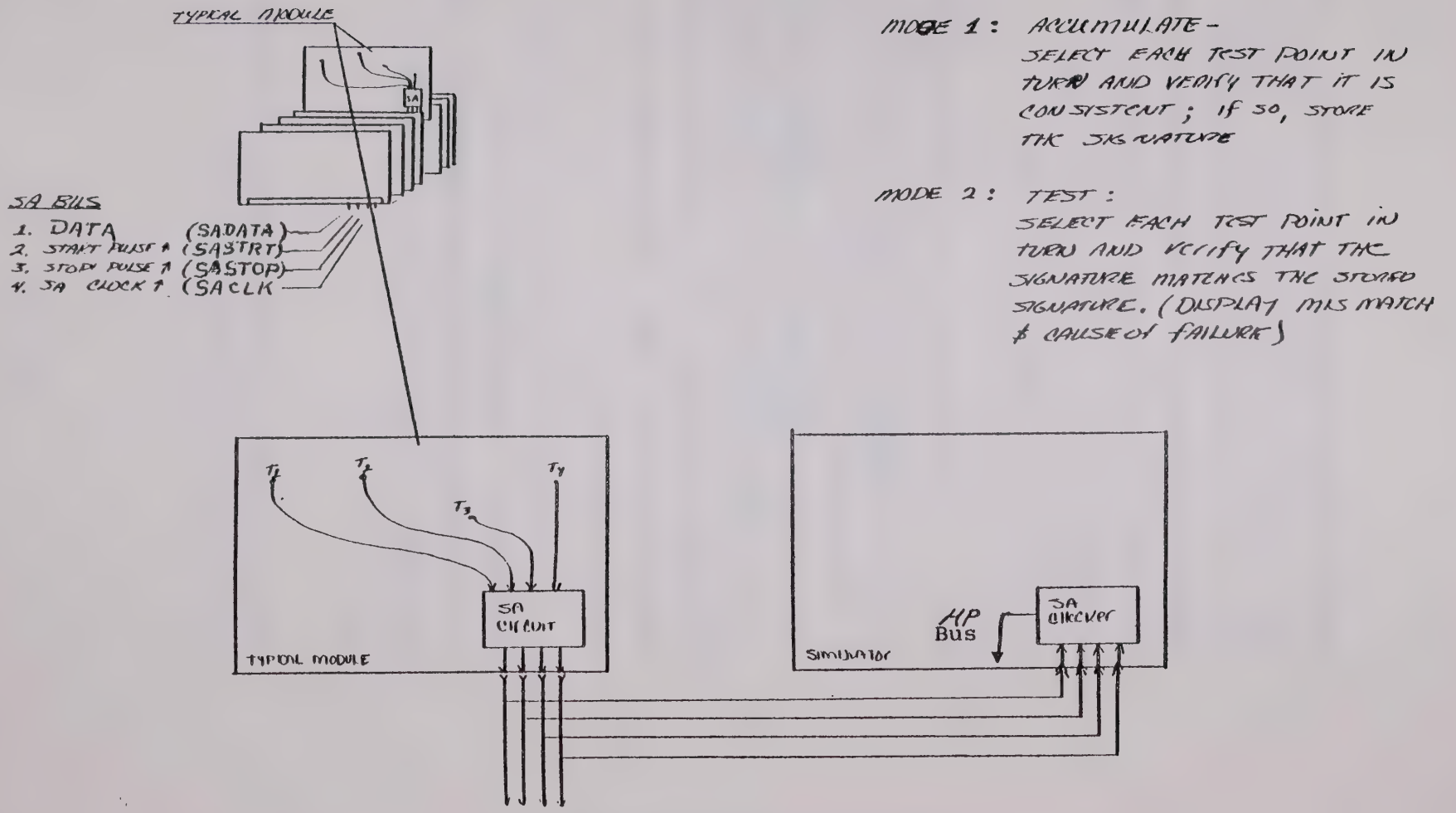
DIAGNOSTIC PAGE DISPLAY

Signature analysis consists of monitoring a digital test point using a start pulse, stop pulse, clock and the test point. These signals are combined to develope an encripted version of the data pattern which permits a 64K bit pattern, for example, to be represented by a 16 bit number. This 16 bit number (similar to CRC character) then can serve as the signature of the selected test point.

Figure 3.12 illustrates the ADS 100 system architecture for signature analysis. Each card has provisions to monitor up to 4 test points. (This represents up to 16 actual tested signals possible per card). The signals are multiplexed onto the system bus in groups of 4 as illustrated and applied to the encoding circuitry. The resulting signature is then verified and stored (Mode 1) or compared with previously stored values (Mode 2).

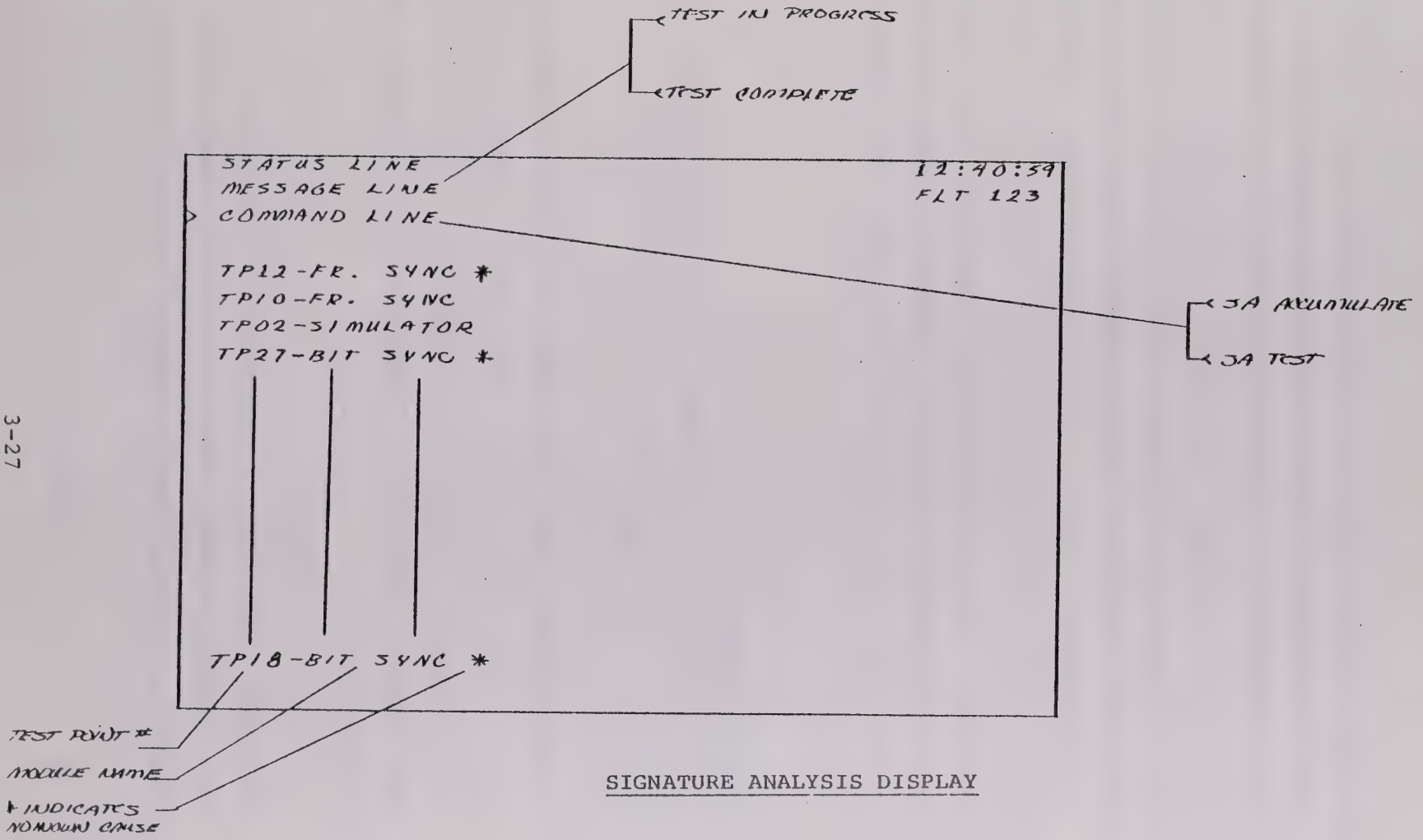
The algorithm is then applied to the derived data and the resulting cause-effect relationship is established. The results are displayed as shown in Figure 3.13.

From this display all malfunctioning test points are determined as well as the module it is on.


TYPICAL MODULE
SA BUS
1. DATA (SADATA)
2. START PULSE ↑ (SASTRT)
3. STOP PULSE ↑ (SASTOP)
4. SA CLOCK ↑ (SACLK)
MODE 1: ACCUMULATE - SELECT EACH TEST POINT IN TURN AND VERIFY THAT IT IS CONSISTENT; IF SO, STORE THE SIGNATURE
MODE 2: TEST: SELECT EACH TEST POINT IN TURN AND VERIFY THAT THE SIGNATURE MATCHES THE STORED SIGNATURE. (DISPLAY MISMATCH & CAUSE OF FAILURE)
SA CIRCUIT
TYPICAL MODULE
HP Bus
SA RECEIVER
SIMULATOR

SIGNATURE ANALYSIS ARCHITECTURE

FIGURE 3.12



SIGNATURE ANALYSIS DISPLAY

FIGURE 3.13

The high temperature warning signifies that a malfunction in the temperature control system has occurred and the unit temperature is in excess of 45°C. If the temperature continues to increase a second notice will be given at 50°C. At 55°C an alarm will be generated to inform the operator the system temperature limit has been exceeded and corrective action should be taken. If no corrective action has been taken and the temperature continues to rise to 60°C the last alarm will be generated and power should be removed until the system has been returned to specified operating limits. Performance is not guaranteed under excess environmental stress.

3.5 Time Correlation

Time correlation is provided by one of three methods; System Internal Time, Embedded Time, or IRIG Decoded Time.

System internal time is provided by an internal counter which can be set by the operator. The counter runs continuously as long as power is supplied to the unit. This time can only be displayed on the CRT and cannot be interleaved onto the MUXbus.

Embedded time refers to time which is an integral part of the PCM data stream. This time is multiplexed onto the MUXbus as any other data parameters. It can be captured

and displayed on the CRT in place of internal time. Because there are no standards to define the time format a universal solution is not feasible. The system, therefore, provides a capability to add unique display algorithms as required by the application. These algorithms are specified on the parameter block pages as unique formats of derived data. (Figure 3.14).

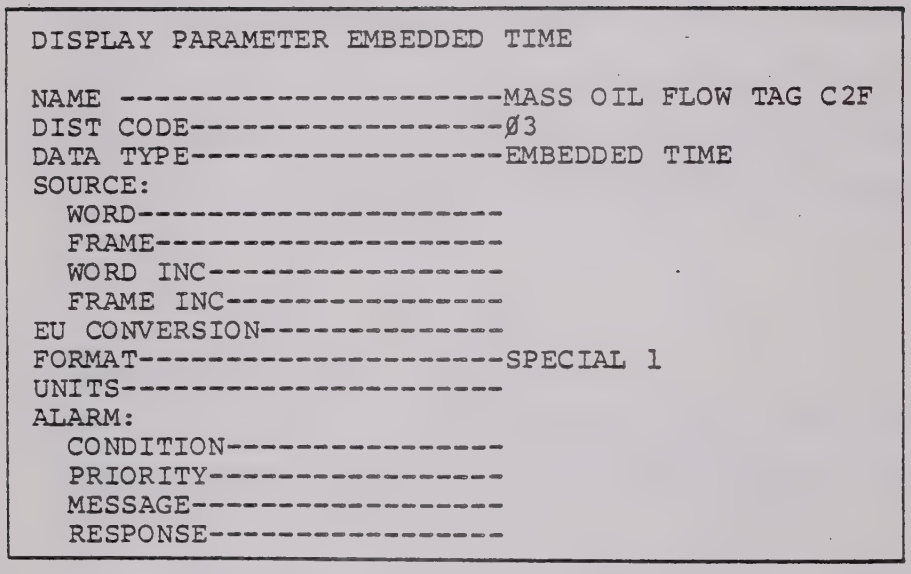


FIGURE 3.14

EMBEDDED TIME DISPLAY

IRIG Decoded time refers to a time standard which is supplied to the unit as a modulated serial data stream. To use this standard it is necessary to install an IRIG decoder module. With this module installed the operator has three choices for establishing time correlation:

1. Appended
2. Periodic
3. External Jam

Appended refers to the capability to trigger the time insertion onto the MUXbus by keying on the occurrence of a specified parameter. For example, if it were desired to insert major time at the beginning of each major PCM frame, the first word of the frame (SYNC WORD 1) would be defined as a prime parameter. This parameter would then be defined as the trigger for major time as shown in Figure 3.18. The resulting composite MUXbus data stream would then consist of the first sync word followed by the inserted time and then the remaining data words. Minor time could likewise be appended to each minor frame. (Figure 3.16).

Periodic time refers to inserting the time word at periodic intervals independent of the data rates. The period can be programmed from .1 milliseconds to 1 second in .1 millisecond increments.

External jam capability is provided to allow an external signal to force a time word at an externally defined time.

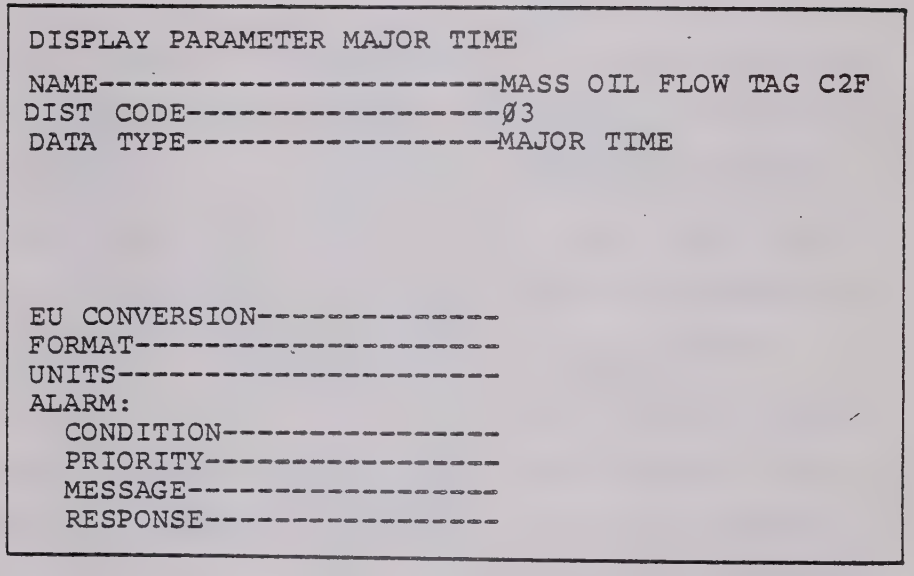


FIGURE 3.15

MAJOR TIME DISPLAY

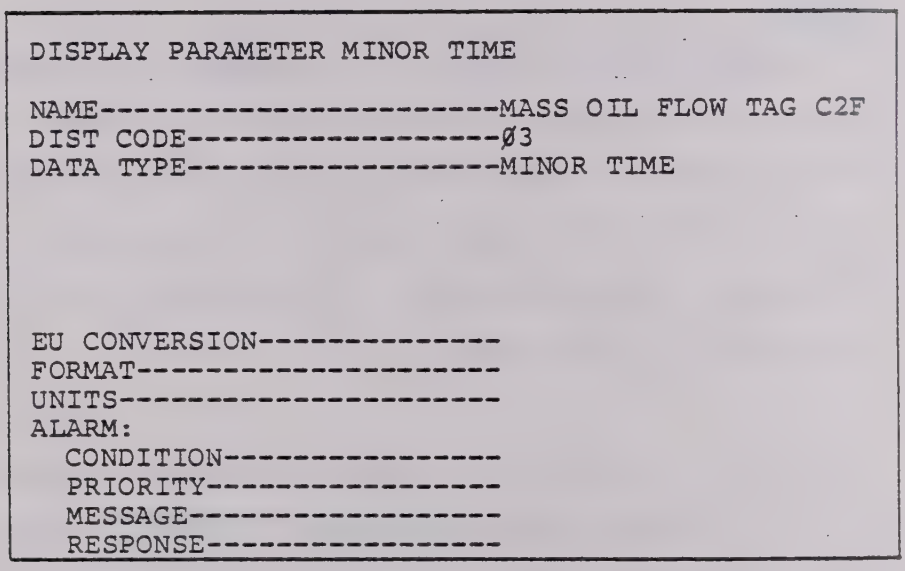


FIGURE 3.16

MINOR TIME DISPLAY

As a side note it can be observed that given this time capability, coupled with the previously described alarm feature, automatic system action can be initiated. For example, if automatic printout of selected data parameter was desired the time alarm condition could be specified as the time of print and the alarm response would indicate the print action.

3.6 Editor

A limited editing capability is included which permits the sophisticated user to tailor the unit for unique applications. The capability is supported by a user software module which defines the system hooks used to alter operation. The system software is also structured to accommodate and provide resources for this task.

The editor consists of a group of commands (described in Table 1) which allows the operator to modify memory and page displays (Figure 3.17)for inspecting the memory contents.

3.7 Parameter Blocks

The parameter block organization is central to the ADS 100 capability. This feature permits the operator to be decoupled from the intricate detail of the telemetry format and allows operational control to flow from a simple understanding of the flight test requirements. It provides for the operator the capability to deal with various telemetry

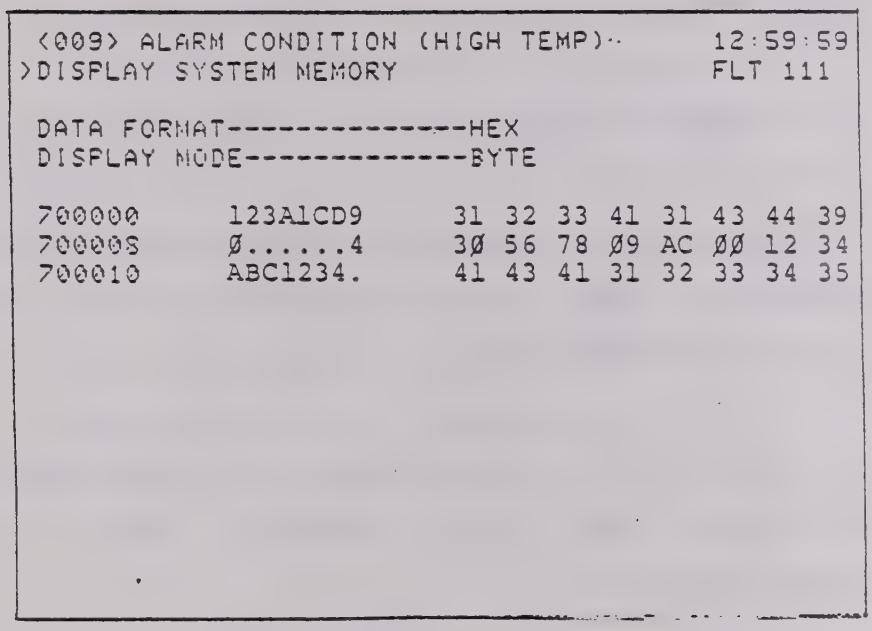

<009> ALARM CONDITION (HIGH TEMP)··
12:59:59
>DISPLAY SYSTEM MEMORY
FLT 111
DATA FORMAT----------HEX
DISPLAY MODE----------BYTE
700000 123A1CD9 31 32 33 41 31 43 44 39
700008 Ø.....4 3Ø 56 78 Ø9 AC ØØ 12 34
700010 ABC1234. 41 43 41 31 32 33 34 35

FIGURE 3.17

MEMORY INSPECTION PAGE FORMAT

formats by a single interface of measurement name and engineering units. In addition, it provides an architectural mechanism to accommodate a wide variety of non-standard requirements.

The parameter block definitions can be divided into 3 general purpose forms and 3 special forms. The 3 general forms deal with prime parameters, processed parameters and derived parameters. The 3 special forms concern major time, minor time and embedded time.

All forms share a common definition of measurement name, distribution code, tag, EU conversion, format, units and alarm parameters.

3.7.1 Measurement Name

A 16 digit string of alphanumeric characters used to identify a data parameter. (Note: A data parameter typically refers to the group of all samples of a single sensor). When using the name to specify a parameter it is not necessary to enter the entire name, only the unique portion. In addition, the unique portion need not occupy a known location nor be consecutive digits. These features are provided with the following conventions:

3.7.2 Tag

The parameter identification tag is a five digit octal number which is appended to the data and serves to guide its flow through the system. The first digit specifies the data stream and the remaining 4 digits specify the parameter name. This provides the capability to process 8 data streams with 4096 parameters per stream.

The operator need not specify the tags but can program the unit to automatically assign unique tags to all parameters. This feature can be overridden if it is desired to assign the same tag to multiple parameter blocks.

3.7.3 E.U. Conversion

Engineering unit conversion operates in conjunction with format and units to define the displayed value and form of the data. The conversion is a 16 character string of numbers and mathematical operators which combine to determine the numeric results. (Note: The symbol "X" defines the independent variable, i.e., data parameter).

3.7.4 Format

The format lines define the form of the displayed value. The form can specify real, floating point, integer, SYMBOLIC or special. Also specified are associated information such as the number of digits.

3.7.5 Units

An 8 digit string of alphanumeric characters which are appended to the right of the displayed value on the data display page.

3.7.6 Alarm

These program variables define the alarm response as explained in Section 3.2 (Alarm System). The alarm condition specifies the values of the data which constitutes an alarm. The condition can be described in terms of the symbols $>$ (greater than), $<$ (less than), = (equal to) and the combination of operators "AND", "OR",. The associated numbers are specified as engineering unit quantities.

The alarm priority number defines which alarm is given priority if two or more alarms occur. The number is programmable as a 3 digit decimal number from 1-256 with 1 interpreted as the highest priority. (Ø indicates no priority and effectively eliminates the alarm response).

Alarm Message is a 12 digit string of alphanumeric characters which are appended to the alarm display.

Alarm Response defines the action to be taken if the alarm condition occurs. Action is limited to one of the following:

Audio	Issue an audio alarm (.25 sec. pulse, 1 sec. 1000 Hz.
Subroutine XXXXX	Executes the subroutine located at the specified memory address.
F1-F14	Execute the command sequence associated with the specified special function button.

3.7.7 Data Type

The 3 general forms of data type are prime, processed and derived. The 3 special forms are major time, minor time and embedded time.

The data type selection determines the format of lines 6 through 10 of the parameter block display page. These lines are then used to define the associated variables.

A prime data type display is shown in Figure 3.18. The digits following the word prime refer to the number of bits in the word and the appropriate code conversion. Source specifies the recurring location which the data occupies in the telemetry format.

Processed data type (Figure 3.19) refers to data which is to be operated on by the data compressor module. Source defines the data parameters which serve as the input to the selected algorithm.

Derived data type (Figure 3.20) refers to data which is operated on by the host microprocessor. It is used to convert data for reintroduction onto the MUXbus. The conversion can include the mathematical combination of two or more data parameters. The conversion character string is limited to 128 characters. The number of derived parameter blocks is limited to 1/4 of the total available record blocks.

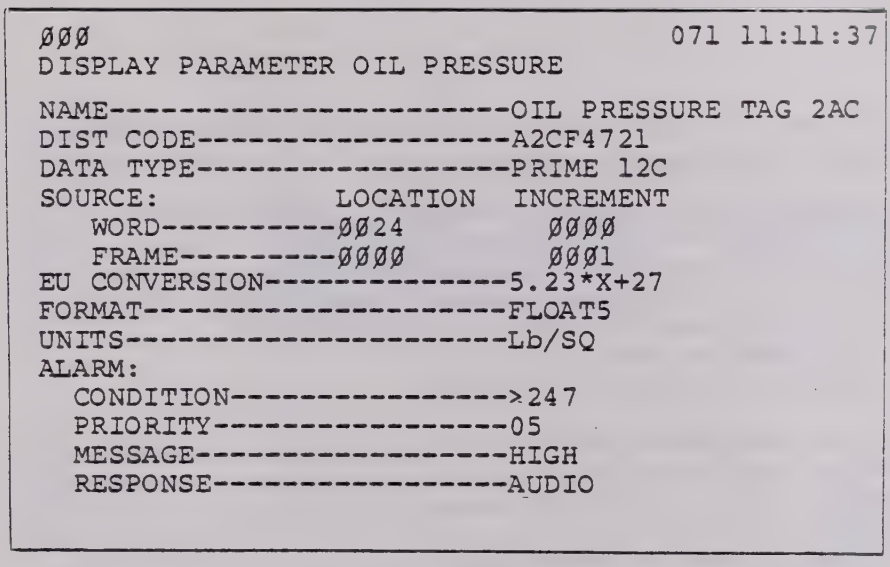


FIGURE 3.18

PRIME DATA DISPLAY

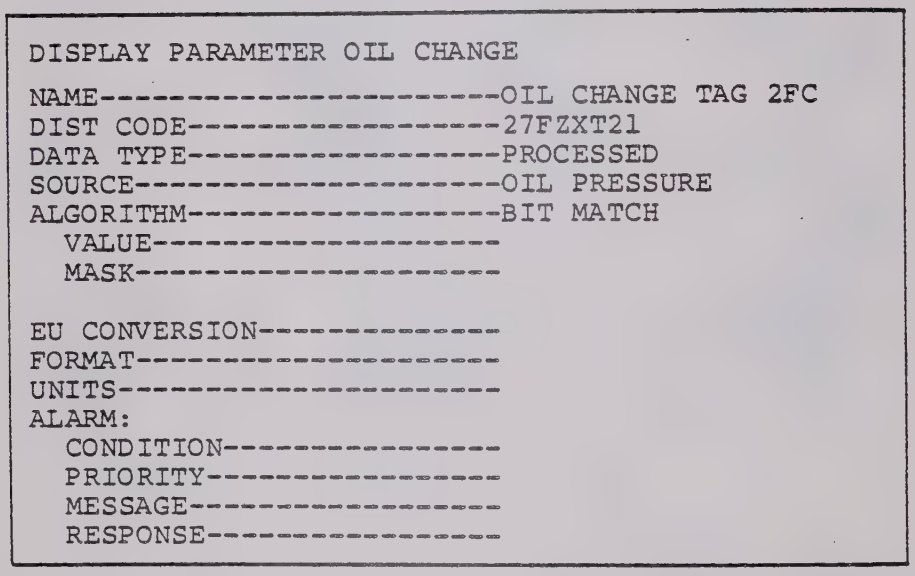


FIGURE 3.19
PROCESSED DATA DISPLAY

```
DISPLAY PARAMETER MASS OIL FLOW

NAME-----------------------MASS OIL FLOW TAG 347F
DIST CODE------------------73A264EB
DATA TYPE------------------DERIVED
VALUE=2*OIL PRESSURE+ 2*TEMP1+TEMP2



EU CONVERSION--------------
FORMAT---------------------
UNITS----------------------
ALARM:
  CONDITION----------------
  PRIORITY-----------------
  MESSAGE------------------
  RESPONSE-----------------
```

FIGURE 3.20

DERIVED DATA DISPLAY

ADVANCED DECOM SYSTEM

SPECIFICATIONS

- DIRECTORY
- BIT SYNCHRONIZER
  - 5 MEGABIT NRZ
  - 2½ MEGABIT BIØ
  - PERFORMANCE WITHIN 1 DB THEORETICAL
- FRAME SYNCHRONIZER
  - PROGRAMMABLE SYNCHRONIZATION STRATEGY
  - PROGRAMMABLE THRESHOLD LIMIT
  - MAXIMUM 65,536 BITS PER MINOR FRAME
- SUBFRAME SYNCHRONIZER
  - PROGRAMMABLE SYNCHRONIZATION STRATEGY
  - PROGRAMMABLE THRESHOLD LIMIT
  - SFID JAM
  - MAXIMUM OF 512 MINOR FRAMES PER MASTER FRAME

CDS

- DATA DISTRIBUTOR
  - MUXBUS INTERFACE
  - REAL TIME LIMIT CHECK
  - MAXIMUM OF 65,536 WORDS PER MAJOR FRAME
  - MAXIMUM OF 4096 WORDS PER MINOR FRAME
  - MAXIMUM OF 1024 PRIME PARAMETERS PER SYSTEM
  - VARIABLE BITS PER WORD (2 TO 16)
- SIMULATOR
  - INDEPENDENT OPERATION
  - SIX SPECIAL WORDS
  - DYNAMIC DATA
  - EXTERNAL ANALOG INPUT
  - EXTERNAL CLOCK
- SYSTEM PERIPHERALS
  - ANALOG PORTS
  - ANALOG/DIGITAL PORTS
  - DATA/TAG PORT
  - I/O INTERFACE
  - REAR PANEL INTERFACE

4.0 SYSTEM SPECIFICATION

The ADS 100 system specification contained herein establishes the performance, design, test and qualification standards for the unit. The unit consists of functional elements bit sync, frame sync, subframe sync, data compressor and associated peripherals.

4.1 Directory

A directory of display pages is available as one of the displayable pages. The directory lists all displayable pages by name and number and tells how many copies of each page are available for display. Multiple copy pages include such types as data display, graph display, parameter pages and bit sync, frame sync, etc. when multiple data streams are used. The directory is displayable by the command DISPLAY PAGE Ø. Pages are listed in two columns with a maximum displayable capacity of 30 pages and a maximum internal capacity of 64 pages. If more than 30 pages are in the directory, the message << use scroll to see more >> will appear at the bottom of the screen (See Figure 4.1).

DIRECTORY DISPLAY SPEC.

Maximum Pages in Directory	64
Maximum Displayable on Page	30
Characters in Page Name (Max.)	12
Columns	2
Oversize Page Option Used	Yes

<ØØØ> 070 13:49:11
>DISPLAY PAGE Ø

PAGE NAME	P#	QTY	D.C.	PAGE NAME	P#	QTY	D.C.
DIRECTORY	Ø	1		GRAPH MENU	1	5	
STATUS	2	1		DATA	3	16	
BITSYNC	4	1		GRAPH	5	5	
FRAMESYNC	6	1		PORTS	7	8	
SUBSYNC	8	1		STAT SUMMARY	9	54	
DISTRIBUTOR	12	1		MAG TAPE I/O	11	1	A
SIMULATOR	14	1		DISK I/O	13	1	C
PARAMETER	16	64		COMPUTER INT	15	1	D
ALARMS	18	1		TAPE DIR	17	1	
FUNCTION KEY	22	15		LOGGER	19	1	E
SIGNATURE	24	27		SENSOR CALIB	21	78	
				MEMORY	23	1	

FIGURE 4.1 DIRECTORY DISPLAY PAGE FORMAT

4.2 Bit Synchronizer

The Bit Synchronizer accepts serial PCM data contaminated with noise from a variety of sources and generates reconstructed serial PCM data and two (2) phase coherent clocks. Input can be programmed for any of the standard IRIG PCM data codes. The output also can be programmed for any of the IRIG codes. Figure 4.2 is the Bit Synchronizer page format.

The standard IRIG Codes used include NRZ-L, NRZ-M, NRZ-S, BIØ-L, BIØ-M, BIØ-S, DM-M, DM-S and randomized NRZ-L (RNRZ-L). Two (2) clocks are provided at the output. They are Bit Rate and 2 x Bit Rate.

4.2.1 Electrical Specifications

Source Inputs:	Three independent source inputs. Input impedance 10K or less if not otherwise specified.
Isolation Between Source Inputs:	At least 80 dB
Data Polarity:	Normal, Inverted
Input Level:	Absolute Max. Voltage: ± 30V Usable Range: 1V to 20V p-p Offset: ±50% of p-p Signal
Available Outputs:	NRZ-L Out; Clock Out; Bit Sync Out; Tape Out; Tape Clock Out
Output Electrical Characteristics:	Output Impedance: 50 ohms Source Current: 50 ma @ 3.0V Sink Current 50 ma @ +.3V
Synchronizing Time:	2 bit transitions or less for an incoming bit rate within ±2% of the selected bit rate with a singal-to-noise ratio (SNR) of 15 dB.
Minimum Transition Density:	Synchronization will be maintained with transition densities as low as 1 transition within 256 bits with a SNR of 15 dB.

4.2.1 Electrical Specifications (Continued)

Noise/Baseline:	1 dB additional degradation for signals with SNR = 15 dB and with baseline variations up to 100% of p-p signal amplitude at frequencies of up to 5% bit rate for BIØ and up to 2.5% with rate for NRZ-L.
Tracking/Noise:	No error for up to ±20% bit rate at input signal SNR = 15 dB.
Bit Rate:	Bit rates from 16 bit/sec to 5 million bits/sec for NRZ, 8 bits to 2.5 million bits/sec for BIØ.
Input Selection:	Three external and simulator.
Bit Error Rate:	Within 1 dB of theoretical.
Internal Filters:	Two internal 6-pole Bessel response filters available in line with the selected input

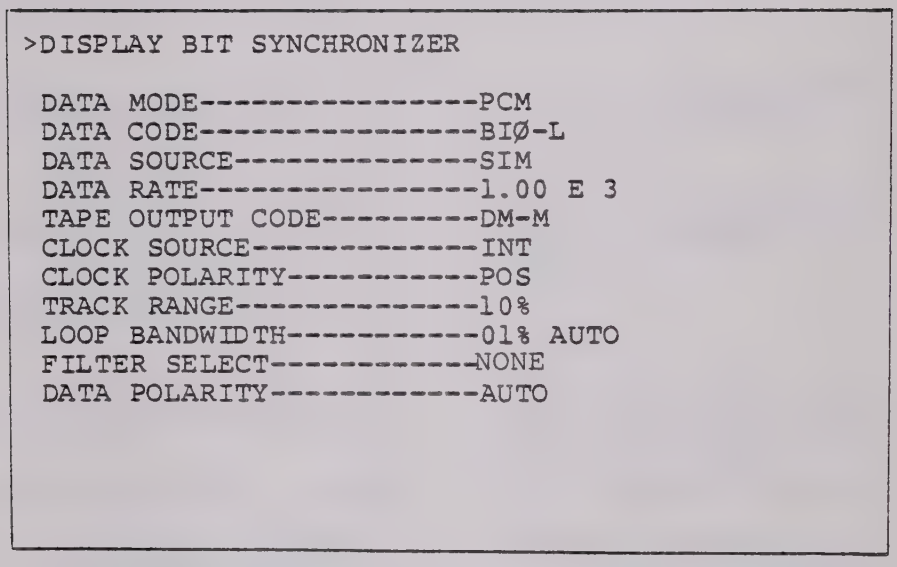


FIGURE 4.2 BIT SYNCHRONIZER PAGE FORMAT

4.3 FRAME SYNCHRONIZER

The frame synchronization and subframe synchronization are integral functions of the ADS Decommutation Unit. Both functions including the program control for an entire decom unit are resident within a single module, the FRAME/SUBFRAME SYNCHRONIZER.

For simplicity, the FRAME and SUBFRAME synchronization will be discussed individually since though they interact, they basically function independently.

4.3.1 Functional Description

The Frame Synchronizer determines the most probable location of the Frame Sync Pattern within the serial PCM data stream, and issues a frame sync pulse to mark this location. Synchronization is performed by a threshold limited, minimum error detection scheme. This scheme allows the operator to specify a minimum data quality threshold which equates to a maximum number of acceptable bit erros in the frame sync pattern. The data location which has the minimum errors and satisfies the programmed threshold limit will be selected.

The Frame Sync Pulse is required by the subframe synchronizer and the data distributor for determining word and minor frame locations. The frame sync pulse is also available on the Motherboard for user needs. See figure 4.3 for the frame synchronizer page format.

```
<ØØØ>                                          071 09:47:42
>DISPLAY FRAME SYNCHRONIZER 1

                    FRAME SYNCHRONIZER

 BITS/FRAME--------------------------65536
 DATA POLARITY-----------------------AUTO
 DATA ALIGNMENT----------------------MSB FIRST
 SYNC APERTURE-----------------------3 BIT


 FRAME SYNC PATTERN                  1011XX0110X
                                     1101110XXXX
                                     XX011001X01

 SYNC STRATEGY
   SEARCH→LOCK-----------------------Ø4
   MAXIMUM ERRORS--------------------Ø7
   LOCK→SEARCH-----------------------Ø9
```

NOTE:

Bits/Frame is system generated from the prime parameter block.

Sync aperature is a 1 or 3 bit window.

FRAME SYNCHRONIZER PAGE FORMAT

FIGURE 4.3

The Frame Synchronizer accepts serial PCM data (NRZ-L) and a one times bit clock from either the ADS internal bit synchronizer or from an external clock via the rear panel and Input Buffer Module. Data input polarity can be normal, inverted or automatically determined. When AUTO polarity is selected (on the Bit Synchronizer Page), the Frame Sync will determine the polarity, and provide a control pulse to the Input Biffer Module to maintain positive polarity data throughout the remainder of the system. The AUTO polarity feature is not available in the Frame Code Complement (FCC) method of subframe synchronization.

The synchronization strategy is enchanced by the programmable Search-to-Lock and Lock-to-Search parameters. When the programmed frame code pattern appears in the expected location in the PCM data stream the number of consecutive times defined by the Search-to-Lock stragegy, the Frame Sync advances the system to the lock mode. The 3-bit window feature, allows the operator to program the system to search for the sync pattern within ± 1 bit position of the expected location. This feature will allow a valid frame sync pulse to be generated, synchronous with data in the event of a 1 bit slip. The Frame Sync Module counts bit slips upto a maximum 255; this value is displayed on the system status page. The slip counter is only active during Verify, Lock, Check modes.

When the operator selects Ø consecutive frames for Search-to-Lock strategy, the sytem will advance to lock when the sync code pattern is detected within the threshold limit. This feature allows for a single burst of data to be captured and processed by the ADS system as soon as the first sync pattern is detected.

4.3.2 Frame Synchronizer Characteristics

Bits per Frame:	16 to 65536 (4K by 16 bit words)
Correlation:	Digital
Pattern:	4-33 bits, any combination of one's, zero's and masks. (Can be expanded to 64 bits with minor software modification).
Pattern Aperture:	Programmable, window, Ø, or 3 bit aperture.
Data Type:	NRZ-L, TTL
Data Polarity:	Manual (normal/inverted*) or auto polarity.
Burst Mode Operations:	Normal/inverted* data only, no pattern errors only.
Threshold Limit:	Programmable, Ø to 7 bit errors in pattern.
Search-to-Lock Strategy:	Programmable (Ø to 15 consecutive frames).
Lock-to-Search Strategy:	Programmable (0 to 15 consecutive frames).
Bit Slip Detector:	When 3 bit window selected only. (cleared by reset) (maximum 255).

* Note, inverted data is converted to normal (positive) on the Input Buffer Module when a manual mode of polarity is selected.

4.3.3 Sync Strategy Controller

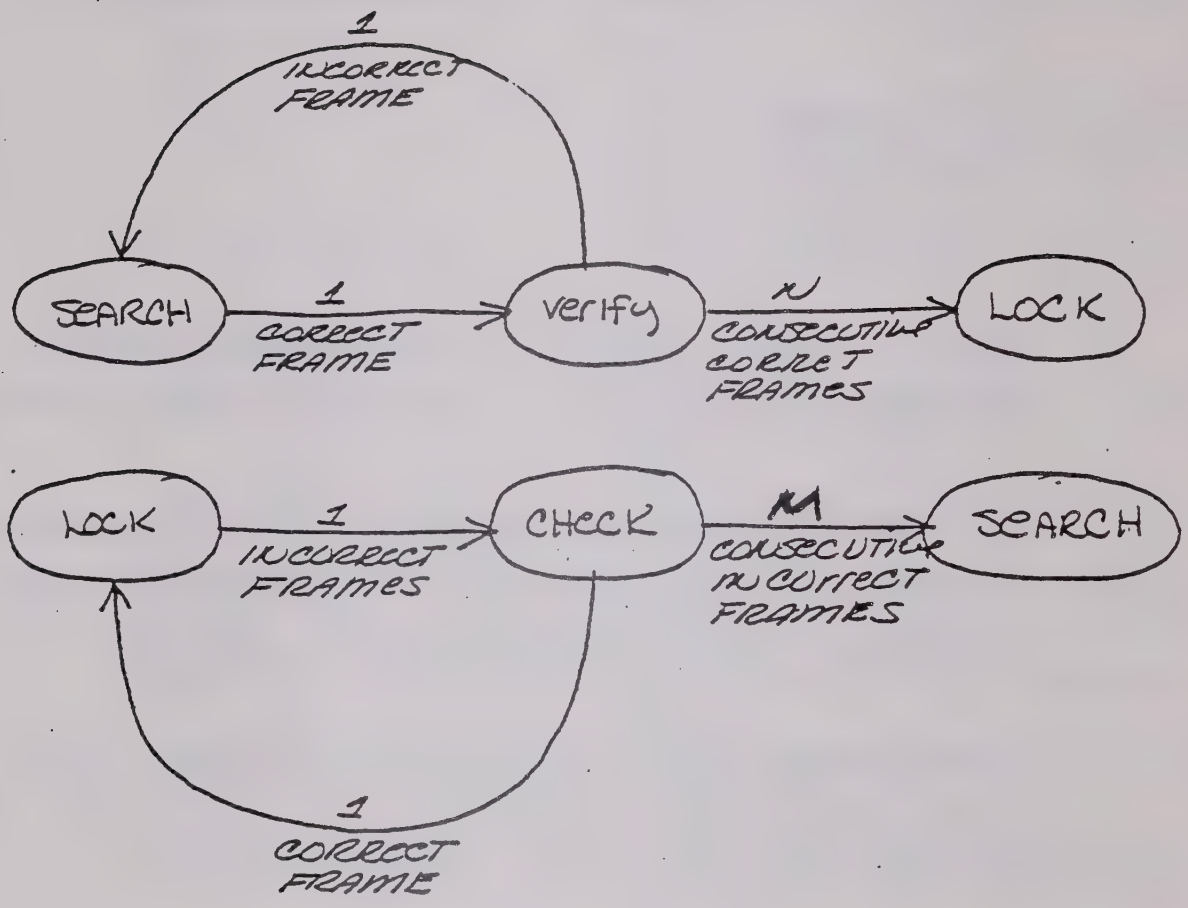
Four system status modes are active in the Frame Synchronizer.

a. Search ØØ
b. Verify Ø1
c. Lock 11
d. Check 1Ø

The Sync Strategy Controller determines when to advance the system status to Verify or Lock mode or when to degrade to Check or Search modes.

The operator selects the search-to-lock and lock-to-search strategy. The values are preset during system initialization into Frame Sync Strategy Register. This register is used to preload counters for the verify and check modes.

If the operator has selected zero search-to-lock, and no errors are detected, the system will advance to lock on the next bit clock following the frame sync pattern.



SYNC STRATEGY

CORRECT FRAME:	A frame of data during which the optimum sync code with less than the required number of errors occurred at the expected location.
INCORRECT FRAME:	Not as above
N & M:	Programmable (0-15)

4.4.1 Subframe Synchronizer

The Subframe Synchronization method selected will determine the strategy utilized to determine the start of a major frame. There are five methods of Subframe Synchronization available in the ADS, each of these are described in Table 4.1.

a. SFIF
b. Sync Code
c. URC
d. FCC
e. FCC/SFID

These modes are selectable on the Subframe Synchronizer Page (Figure 4.4).

The Subframe Synchronizer generates a Subframe Sync ($\overline{SFS}$) pulse once each major frame. The Subframe Synchronizer also generates minor frame number. The minor frame number is used by the Data Distribution for determining major frame locations, and is also available on the MUXbus

TABLE 4-1

URC - UNIQUE RECYCLING CODE

A unique (meaning not the same as the frame sync code or its complement) sync pattern is substituted for the minor frame sync code at the beginning of each major frame.

FCC - FRAME CODE COMPLEMENT

A special case of URC where the unique code is the complement of the minor frame sync code. Often used to extend the effective frame sync length by alternation of each minor frame.

SYNC CODE

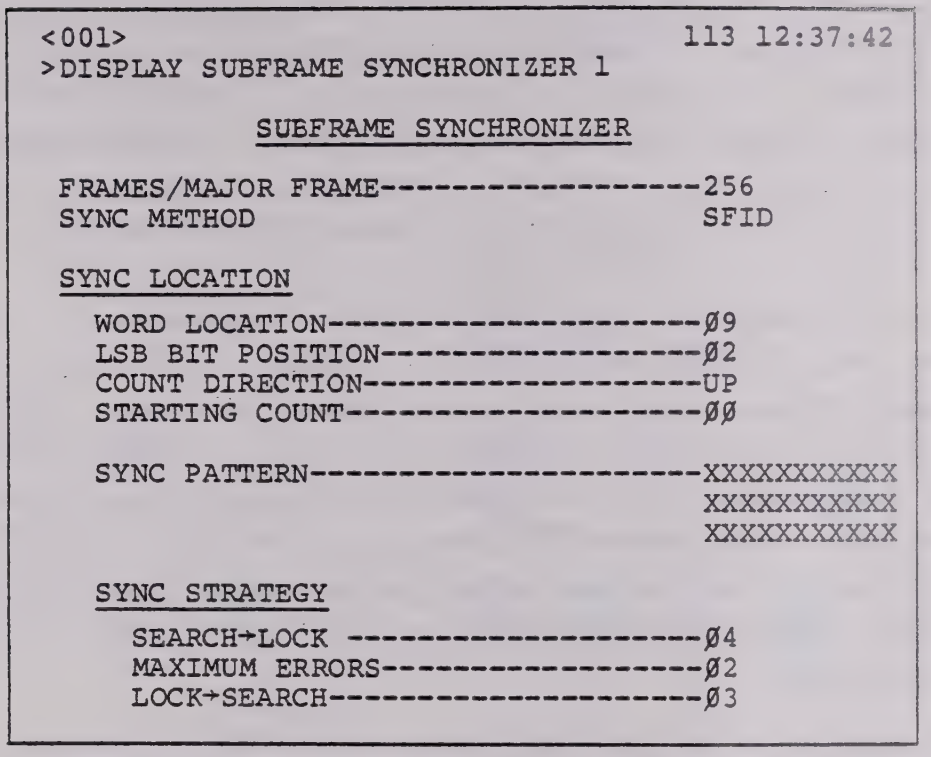
A fixed pattern of 1 and 0's occupying one or more consecutive subframe channel word locations at the beginning of each frame.

SFID - SUBFRAME IDENTIFICATION

A counting code which occupies an entire subframe channel. It may count up or down, LSB or MSB first, start with any count. If counting up it will increment by one each minor frame and restart at the beginning of the frame.

FCC/SFID

A special case of FCC, where the frame sync is complemented alternately each minor frame, and there are more than 2 frames/major frame. In this case a SFID code is required to identify the frame number, and the FCC is used for frame synchronization.



EXAMPLE (SFID)

NOTE:

Sync pattern is used only during sycn code and URE methods of synchronization.

SUBFRAME SYNCHRONIZER PAGE FORMAT

FIGURE 4.4

Sync Code, URC, FCC methods of synchronization is similar to the Frame Sync threshold limited, minimum error detection scheme. The essential difference is that auto polarity resolver is not required. Programmable lock-to-search, and search-to-lock parameters enhance synchronization and lock. If zero search-to-lock is selected, the system will immediately advance to lock when a sync pattern within the threshold is detected.

The SFID method of synchronization is referred to as SFID jam. The operator designates the SFID and bit word location in the minor frames. The operator also specifies the starting ID, and the count direction (up/down). The SFID correlator captures the SFID code from the data frame, determines derived frame number and jams this number to immediately set the frame number. The SFID method is the most effective method of Subframe Synchronization. Subframe Synchronization in FCC/SFID mode is identical to SFID method.

Search-to-Lock and Lock-to-Search strategy is similar to the Frame Synchronizer.

4.4.2 SUBFRAME SYNCHRONIZER CHARACTERISTICS

Frames/Subframes: (minor/major frames)	1 - 512 maximum. Must be an even number when >256
Correlation:	Digital
Synchronization Methods:	SFID (Jam) SYNC CODE URC FCC FCC/SFID (Jam)
Data Type:	NRZ-L, TTL
Data Polarity:	Normal
Burst Mode Operations:	No Errors (SYNC Code, URC,FCC) JAM (SFID), FCC/SFID
Threshold Limit:	Programmable, Ø to 7 bit errors
Search-to-Lock Strategy:	Programmable (0 - 15 consecutive Major Frames)
Lock-to-Search Strategy:	Programmable (Ø - 15 consecutive Major Frames)

4.5 Data Distributor

The data distributor (D/D) hardware performs the interface from the serial data stream from the frame sync to the MUX-bus. The D/D serializes, tags and limit checks all data in this stream which have been identified by parameter blocks. The D/D uses the sync pulses, frame count and subframe count to determine the proper tag for the word coming in. Once this is done, the word may be de-serialized to the proper length, tagged and limit checked. The D/D also checks parity and converts data codes (2's complement, etc.). The Data Distributor page format is shown in Figure 4.5.

The Data Distributor has the following characteristics:

Bits/Word	2 - 16
Parity	ODD, EVEN, OFF
Data Alignment	MSB, LSB First
Data Format	2's complement, Offset Binary, Binary, BCD
Conditional Output	Output in Search, Verify, Check and Lock individually programmable based upon a hierarchy scheme.
Prime Parameters	Maximum of 1024 per minor frame
Words/Minor Frame	Maximum of 4096 per minor frame
Words/Major Frame	Maximum of 65,536 per master frame

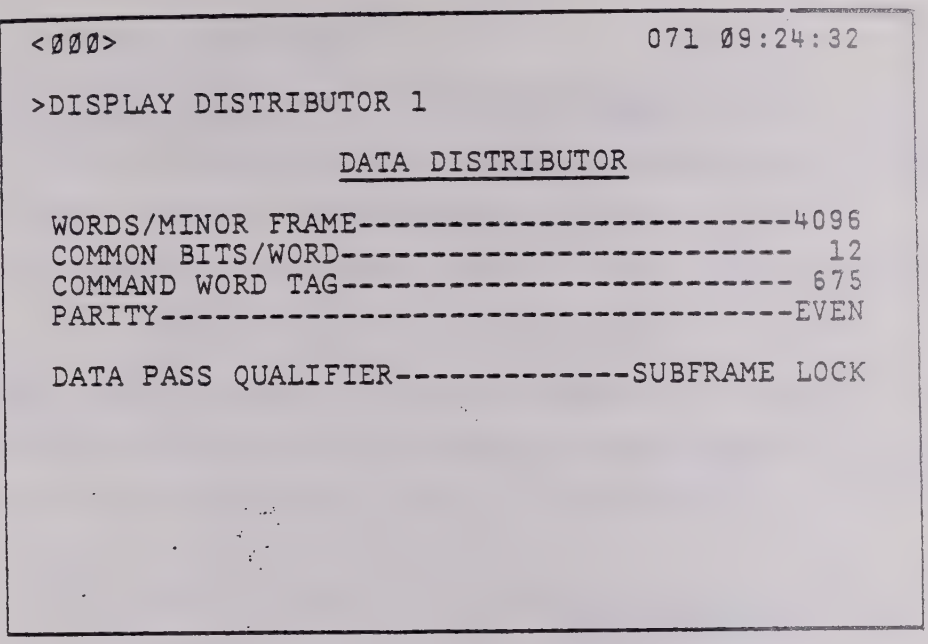


FIGURE 4.5

DATA DISTRIBUTOR PAGE FORMAT

4.6 Simulator

The simulator provides the unit with self-test capabilities by supplying a formatted PCM telemetry stream. The simulator can produce all acceptable IRIG codes, lengths and sync methods, etc. It also provides the capability to simulate the parameter data by inserting dynamic data. Dynamic data can be generated internally or externally. Internally generated data is from one of four function generators. Externally generated data will be from an analog input.

Bit Rate (Internal and External):	From 16 bps to 5 mbs
Bit Rate (System):	From 16 bps to 5 mbs programmed. (Programmable to 1% of bit rate).
Clock Source:	Internal (from the bit Sync Clock) External (via BNC to back panel) System (See Bit Rate)
Polarity:	Normal or Inverted
Available Outputs:	Simulator Out; Simulator Clock Out
Output Electrical Characteristics:	<u>Simulator Clock Out</u> Output Impedance: 50 ohms Source Current: 50 ma @ 3.0V Sink Current: 50 ma @ .3V <u>Simulator Out</u> Output Impedance: 50 ohms Drive Capability:
Available Inputs:	Simulator Analog In; Ext. Clock in

Simulator (Continued)

Input Electrical Specifications:	Simulator Analog In: ± 10V p-p max. (MSB FIRST, 10Bit/Word max) 10K ohms minimum input impedance External Clock In: Logic Levels: "1" = 2V dc @ .9 ma max. "0" = 1V dc @ .9 ma max.
Function Generator:	256 steps; Sine, Square, Triangle, Random, incremented at the frame rate.
Common Word Value:	Variable Bits/Word 16 bit binary + parity max (LSB truncation)
Special Words:	6 Selectable
Value:	Variable Bit/Word 16 Bit Binary + parity (max) Function Generator or External Analog Input
Formats:	65,536 total words/major frame 4 to 4096 words/frame 1 to 512 minor frames/major frame Total words = (words/frame) X (minor frames/major frame) not to exceed 65,000 words.
Synchronization Word Type:	Programmable to any format desired.
Data Codes:	Programmable to all IRIG-B codes including RNRZ-L.

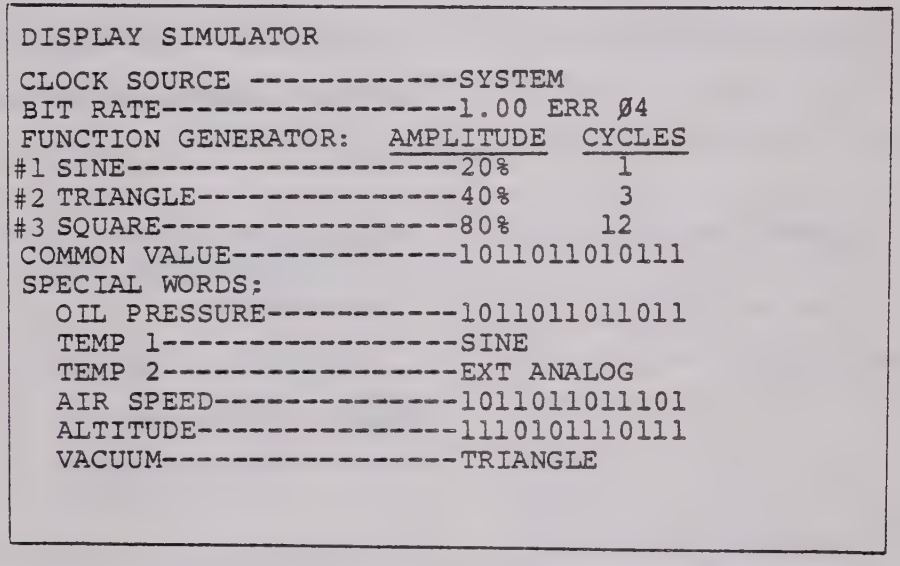


FIGURE 4.6 - SIMULATOR PAGE FORMAT

4.7.1 Analog Ports

The module captures selected data from the MUXbus and converts the digital data into an analog voltage. There are eight analog ports per card. See section 4.7.2 for specifications.

4.7.2 Analog/Digital Ports

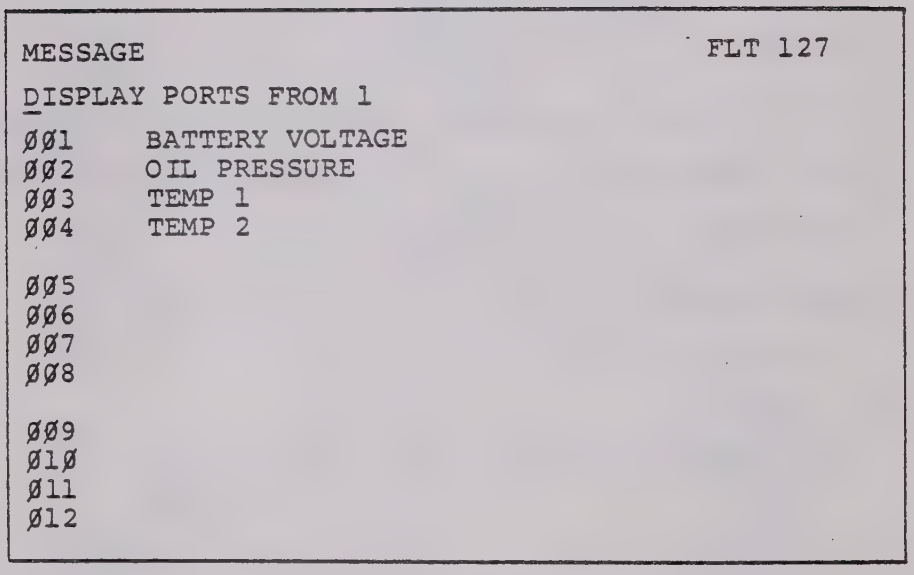
The port captures selected data from the MUX bus and converts the digital data into an analog voltage. It also provides the selected data as a 16 bit parallel word. (There are four analog/digital ports per card). (See Figure 4.38 for display format).

ANALOG OUTPUT:

Resolution:	12 Bits
Accuracy	±1 LSB
Linearity	±1/2 LSB
Noise	800 microvolts
Voltage	±5, ±10 (Switch Select)
Drive	±10 Volts (2K Load) ±5 ma
Capacitive Load	1000 pf
Slew Rate	20 Volts/usec (200 pf)
Output Impedance	50 ohms

DIGITAL OUTPUTS:

16 Bit Parallel	MSB Aligned
High Drive	>2.4 volts 4 ma
Low Drive	< .4 volts 12 ma
Handshake	Strobe, Ready, Enable



ANALOG/DIGITAL PORTS
DISPLAY PAGE

FIGURE 4.7

4.7.3 Data Tag Port

The Data/Tag-Event Monitor Port allows an external device to monitor selected parameters on the ADS 100 MUXbus. The Tag Event Decode comparators are switch selectable so that the user can select which parameters will give an event occurance signal.

The port can operate in either of two modes. In the first mode, called the packing mode, two eight bit parameters that appeared on the MUXbus (one right after the other) will be packed into a sixteen bit output word. The strobe will be issued to the external device so that the packed data, and tag of the last parameter, can be latched into a buffer. The port assumes that the data was latched and will load up the next two 8 bit words and issue another strobe.

In the second mode, called the normal mode, whenever a parameter appears on the MUXbus (that is to be accepted by the port) both the data and tag are latched. After the latching has been completed, a strobe will be issued for latching this data into the external devices buffer. Here again, the port assumes that the data was externally latched and will continue to monitor for preprogrammed parameters.

4.7.4 I/O Interface Module

The Input/Output Interface Module is designed to interface with a versatile serial communications port, a high speed parallel line printer, a bi-directional, 8 bit computer port, and the general purpose IEEE-488 bi-directional data bus.

4.7.4.1 Serial Communications Interface

The serial communications port is field modifiable from RS232 to 20 ma current loop, or TTL levels through the selection of dip switches located on the I/O module. During 20 ma current loop operation, an active or passive mode may be selected through dip switches located on the I/O module. Pre-fabricated cables are available which directly interface to the I/O module through the Rear Panel Interface Module. Sixteen baud rates from 50 to 19,200 BAUD are selectable through the keyboard, thereby requiring no hardware changes.

BAUD RATES:

50	1200
75	1800
110	2000
134.5	2400
150	3600
200	4800
300	9600
600	19,200

4.7.4.2 High Speed Line Printer

The High Speed Line Printer interface is an eight bit ASCII coded parallel output port requiring a minimum of handshaking. The I/O Module monitors the line printer "READY" line (or equivalent) and outputs data when this line is active to achieve maximum throughput. This option is intended to provide a hard copy printout of program listings, block dumps, out of limit conditions, and page display dumps. Access is through the Rear Panel Interface.

4.7.5 Rear Panel Interface

The rear panel interface module provides the circuitry and connectors to couple external signals to the ADS 100 and internal signals to peripheral devices.

The back panel interface is designed for the users convenience so that all connections to the system will not interfere with the operator when the system is on line.

The standard features included in the back panel are:

- MUXbus
- Processor Bus
- Status Bus
- Video Output
- Tape Output
- Clock Output
- SIMCLK Output
- NRZ-L Output
- Simulator Output
- External Clock Input
- External NRZ-L Data Input
- Simulator Analog Input
- 3 PCM Source Inputs
- Bit Sync Out
- Bit Sync CLK
- Tape CLK Out